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GENERAL

579 Operation Sandstone; the Story of Joint Task Force Seven. Clarence H. White, ed. Washington, Infantry Journal Press, 1949. 104p.

This is a pictorial history of Operation Sandstone (during the months of April and May, 1948) in the "attainment of a milestone in the development of atomic energy." Although this operation was concerned with the testing of atomic weapons, valuable information pertaining to civilian employment of atomic energy was gained. The operation performed by Joint Task Force Seven was the optimum of integrated effort, involving approximately 10,000 individuals drawn from the Armed Forces and civilian pursuits.

580 Potentialities of Atomic Warfare Against the U. S. Petroleum Industry. Robert C. Wing. U. S. Naval Inst. Proc. 75, 983-7(1949) Sept.

Atomic bomb attacks on the petroleum industry might be separated into possible phases. First, the facilities of the industry itself might be attacked and, second, port and shipping facilities might be hit. Oil fields are not particularly vulnerable since they are scattered throughout the country, but refineries present concentrated targets. It is estimated that one bomb could cover the entire area of a refinery and do particular damage to storage areas. However, attacks against harbors would not be as effective because of the large number of alternate ports available, and the possibility of improvising port facilities.

581 Atomic Power and Fuel Supply. Ward F. Davidson. Mech. Eng. 71, 999-1003(1949) Dec.

The author presents some basic facts on how fission is initiated, the amount of heat released by one pound of uranium as compared to one pound of coal, and a brief discussion of the chain reaction. The main points discussed, for power production, are: fundamental design problems, nuclear fuels, general reactor design, the problem of heat transfer, how control of the reactor is accomplished, shielding of personnel and equipment, means for replenishing the charge in a reactor, steam generator and some auxiliaries, comparative costs of power obtained from a reactor or coal-burning stations, and some factors influencing costs.

BIOLOGY AND MEDICINE

582 The First International Congress of Biochemistry, Cambridge, Aug. 19-25, 1949. D. H. Moore and C. E. Sunderlin. Office of the Assistant Naval Attache for Research, London Branch. Sept. 6, 1949. 80p. (NP-1129).

The First International Congress of Biochemistry was held in Cambridge, August 19-25. More than 500 papers were presented by biochemists from 42 countries, and approximately 1800 scientists attended the meeting. The presentation of papers was divided into the following 12 sections: animal nutrition and general metabolism; microbiological chemistry; enzymes and tissue metabolism; proteins; clinical biochemistry; structure and synthesis of biologically important substances; cytochemistry, biological pigments; oxygen carriers and oxidizing catalysts; hormones and steroids; chemotherapy and immunochemistry; plant biochemistry; industrial fermentations. This report summarizes and discusses many of the important papers presented at the conference. A complete program of the conference and portions of two supplementary reports summarizing the conference are appended.

BIOLOGY AND MEDICINE

583 Molybdenum Metabolism and Interrelationships with Copper and Phosphorus. C. L. Comar, Leon Singer, and George K. Davis. J. Biol. Chem. 180, 913-22(1949) Sept.

Tracer amounts of Mo^{99} were given orally and intravenously to 14-month steers in order to investigate the copper-molybdenum relationships. A table is included which lists the distribution of the Mo^{99} throughout the body. Experiments were also performed on rats with radioactive Cu^{64} and P^{32} in conjunction with the nonradioactive forms of the three elements under consideration. The dependence of low level molybdenum toxicity upon the dietary copper uptake in the rat was demonstrated, and a similarity of action of molybdenum and phosphorus in the bovine was shown. The results of the interrelationship studies in the rat with radioactive elements suggest to the authors that the toxic action of molybdenum may be due to the following mechanisms, listed in the probable order of importance: interference, due to a lowered liver copper, in enzymes systems necessary for skeletal metabolism; inhibition of the enzyme systems by molybdenum; and, competition between phosphorus and molybdenum for deposition in the bone. 14 references.

584 The Action of Ethanolamine, Methylethanolamine, and Dimethylethanolamine on Lipide Phosphorylation. Camillo Artom and W. E. Cornatzer. J. Biol. Chem. 176, 949-59(1948) Nov.

Each of a number of male albino rats, maintained on a low fat, low protein diet, received a single dose of ethanolamine, methylethanolamine, dimethylethanolamine or choline (1 cc of a 0.2M solution by stomach tube) and 5 min later was injected intraperitoneally with a solution of Na_2HPO_4 (10-20 γ of P) containing 2-4 μc of radioactive phosphorus P^{32}; 6 hr later the animals were sacrificed and the lipids were extracted from the liver and the small intestine and their radioactivity and phosphorus contents were determined. It was found that all the substances tested stimulated the formation of total phospholipids in both tissues; the stimulation created by ethanolamine was the same as that of choline. On separation of the phospholipids, the results showed that after methyl- and dimethylethanolamine and ethanolamine were given the radioactivity was increased in both the choline-containing and the non-choline-containing fractions of the phospholipids; but after administration of the choline radioactivity increased only in the choline-containing fraction of the phospholipids. 28 references.

585 Biochemical Studies on Diphenhydramine (Benadryl). III. Application of Radioactive Carbon to Metabolic Studies of Benadryl. Anthony J. Glazko, D. A. McGinty, Wesley A. Dill, M. L. Wilson, and C. S. Ward. J. Biol. Chem. 179, 409-16(1949) May.

A dose of 10 g/kg body weight of Benadryl with C^{14} incorporated into the molecule at the α position of the benzhydryl group and with a specific activity of 224 μc/g was injected subcutaneously into each of two guinea pigs. The animals were sacrificed 75 min later; the tissues were removed, frozen rapidly and stored until analysis by the methods described. It was found that the results of the radioactivity and chemical methods of analysis of the Benadryl agreed closely; the urinary excretion of nonbasic metabolic products of Benadryl was shown by the radioactivity method and accounted for a larger percentage of the administered dose than was possible before. The preparation of radioautographs from paper strip chromatograms demonstrated the presence of Benadryl and a number of degradation products. 11 references.

586 The Biological Formation of Serine from Glycine. Philip Siekevitz and David M. Greenberg. J. Biol. Chem. 180, 845-56(1949) Sept.

Rats of the Wistar-Slonaker strain were sacrificed after 24 hr fasting and their livers were excised, sliced, and incubated with various radioactive substrates and media for 3 hr in each case. Anaerobic experiments were carried out in an atmosphere of nitrogen, while the aerobic experiments were conducted in air; glycine labeled with C^{14} in either the α carbon or the carboxyl carbon was used. It was found that the synthesis of the serine occurred under both anaerobic and aerobic conditions; labeled formate (derived from glycine) and unlabeled glycine were capable of producing serine labeled in the β carbon. The α carbon of glycine appeared as formate in an irreversible reaction while the carboxyl carbon was metabolized, probably to carbon dioxide; carbon dioxide was not reduced to formate by the rat liver slices. It is concluded from a study of the radioactivity in the β carbon of serine that there is another source of formate in the fasted rat liver slice which is more active anaerobically than aerobically. 18 references.

587 Carbamates in the Chemotherapy of Leucemia. VII. The Rate of Catabolism of Urethane in Normal and Neoplastic Mice. Jack H. Mitchell, Jr., Oliva S. Hutchison, Howard E. Skipper and Carl E. Bryan. J. Biol. Chem. 180, 675-80(1949) Sept.

An experiment to determine whether the increased retention in the tissue of the carbonyl carbon from urethane observed in neoplastic mice is in the form of urethane or of a metabolite of this compound is described. Normal CFW strain white mice were used as controls for the AKm strain mice with spontaneous lymphoid leucemia and CFW strain mice with spontaneous mammary carcinoma and methylcholanthrene-induced mammary carcinoma; the animals were injected with 1400 mg/kg of carbonyl-labeled urethane containing an activity of 2 μc or with an equal amount of nonradioactive urethane. On chemical analysis, the blood from the normal mice showed that the urethane was practically all eliminated 24 hr after injection, but the blood of mice with spontaneous mammary carcinoma contained about 21% higher concentration of urethane; the amount of urethane in the blood of the mice with methylcholanthrene-induced

mammary carcinoma agreed closely with the spontaneous mammary carcinoma group. It is concluded that the excess radioactivity observed in the neoplastic animals is due primarily to free urethane and results from a lower rate of catabolism of the urethane in these animals.

588 Compounds Related to Dimethylthetin as Sources of Labile Methyl Groups. George A. Maw and Vincent du Vigneaud. J. Biol. Chem. 176, 1037-45(1948) Dec.

Among the compounds investigated as possible sources of labile methyl groups and able to substitute for betain or dimethylthetin in choline-methionine-free rat diets when homocystine is present are S-methylthioglycolic acid, methylethylthetin, diethylthetin and dimethyl-β-propiothetin. In the feeding experiments young male albino rats of the Rockland strain were used; they were maintained on a preliminary diet containing casein, then on a diet containing pure amino acids and DL methionine and, after selection, some of the rats were placed on a diet consisting of homocystine and the compound being tested; S-methylthioglycolic acid was transformed into S-trideuteriomethylthioglycolic acid for tracing purposes. It was found that dimethylpropiothetin is a highly active methyl donor, while methylethylthetin is less active and diethylthetin is inactive; their efficiencies as lipotropic and kidney antihemorrhagic agents follow the same pattern. S-methylthioglycolic acid is unable to support growth or to protect animals against renal hemorrhage damage, and it is not an efficient methyl donor. The relationship of methyl-donating ability to chemical structure is discussed. 22 references.

589 Concerning the Application of Radioiodine I^{131} as an Indicator of Thyroid Activity After the Action of Gonadotrophin, Male and Female Sex Hormone. J. H. Müller and H. Aeppli. Experientia 5, 297-9 (1949) July 15. (Short communication, in German).

The function of the pituitary gland was studied by measuring the uptake of I^{131} in the rat thyroid. Adult female rats were kept on a iodine-free diet and were injected subcutaneously twice weekly over a period of two months with gonadotrophin, Perandren, or Ovocyclin. The animals were then given 15-20 μc of I^{131}, and were sacrificed after 47 hr; the thyroids were excised and measured for radioactivity. High doses of the sex hormones showed an inhibitory effect on the pituitary gland, demonstrated by a diminished I^{131} uptake resulting from a lowered thyrotrophic hormone production. It is concluded that the procedure presented here may be used as an indicator of the clinical efficacy of hormones prescribed for the menopausal syndrome.

590 The Conversion of Formate and Glycine to Serine and Glycogen in the Intact Rat. Warwick Sakami. J. Biol. Chem. 176, 995-6(1948) Nov. (Letter to the editor).

The conversion of glycine to serine and serine to pyruvate was investigated by degrading liver serine and glycogen isolated after the simultaneous administration of glycine labeled with C^{13} in the carboxyl group and formate contain-

ing C^{14}. Four fasted rats were given 5 mM of glycine by stomach tube and 0.125 mM of the formate intraperitoneally per 100 g body weight; the latter dose was repeated after the fifth hr and after 14 hr the animals were sacrificed. Glycogen was extracted from the livers with trichloroacetic acid and degraded; serine was isolated from the neutral amino acid fraction of the liver hydrolysate as the p-hydroxyazobenzene sulfonate and degraded. The results of the carbon analyses indicated that the serine contained a considerable amount of C^{13} and C^{14} (all of C^{13} in the carboxyl carbon and most of C^{14} in the β carbon), as did glycogen (C^{13} in the 3,4 carbons and C^{14} in the 1,6 positions). It is concluded that the absence of C^{13} from the β carbon in serine proves that this carbon does not arise from formate via CO_2 fixation, and expresses the likelihood of a pathway for the conversion of glycine and formate to glycogen via serine and pyruvate.

591 The Conversion of Methionine to Cystine in a Human Cystinuric. Lester J. Reed, Doriano Cavallini, Fred Plum, Julian R. Rachele, and Vincent du Vigneaud. J. Biol. Chem. 180, 783-90(1949) Sept.

Radioactive methionine, containing approximately 100 μc of S^{35}, was fed to a human cystinuric, and radioactive cystine was isolated from the urine and from newly grown hair. Most of radioactive sulfur (81.6%) was retained by the subject during a period of 4 days, 2.6% being excreted in the form of cystine. There was loss of the sulfur into the urine over a period of about 70 days, most of the excretion taking place on the first day (13.3%). It was noted that the radioactivity of the neutral sulfur-excreted fraction was greater than that of the cystine fraction, but it is concluded that this was not due to excreted methionine. The results obtained here are compared with those from dog experiments. 22 references.

592 The Degradation of Aminoadipic Acid in Guinea Pig Liver Homogenate. Henry Borsook, Clara L. Deasy, A. J. Haagen-Smit, Geoffrey Keighley, and Peter H. Lowy. J. Biol. Chem. 176, 1395-1400(1948) Dec.

The synthesis, resolution, and degradation in a guinea pig homogenate of α-aminoadipic acid labeled with C^{14} in the ϵ position and the synthesis of α-ketoadipic acid are presented in this report. It was shown that in the homogenate the α-aminoadipic acid was oxidatively deaminized to α-ketoadipic acid and the latter was oxidatively decarboxylated to glutaric acid; the deamination of the α-aminoadipic acid was much slower than its formation from L-lysine and the decarboxylation of α-ketoadipic acid.

593 Distribution and Metabolism of Iodo-α-Estradiol Labeled with Radioactive Iodine. S. Albert, R. D. H. Heard, C. P. Leblond, and Judith Saffran. J. Biol. Chem. 177, 247-66(1949) Jan.

α-estradiol was iodinated with radioiodine under conditions such that about half the iodine was substituted as mono- and half as diiodo-α-estradiol; these compounds proved to be physiologically inert at 100 γ. The material was administered to mice subcutaneously in doses of 1.7-18.0 γ; some animals

were treated with pure diiodo-α-estradiol in doses of 0.5-2.0 mg. After 10-12 hr, the distribution and excretion of the radioactivity were examined in about forty organs and tissues. The outstanding observation was that in the metabolism of the iodinated α estradiol collected, labeled material collected in the gastrointestinal tract, gaining entry from the bile and liver. The highest concentration of radioactivity was usually found in the mammary glands, although the other accessory sex organs contained little activity. Acid hydrolysis indicated that only a part of the radioactivity can be combined in the conjugated form in the small intestine, liver, mammary glands, and urine, but not the feces. The iodinated α estradiol showed rapid resorption from the site of injection, swift departure from the blood plasma, entry into red blood cells, marked excretion in the bile, and moderate excretion in the urine, mainly in the conjugated form; unesterfied estrone and estradiol have similar properties. 36 references.

594 The Distribution in Normal Tissues of Radioactive Sulfur Fed as Labeled Methionine. Alfred R. Maass, Frank C. Larson, and Edgar S. Gordon. J. Biol. Chem. 177, 209-16(1949) Jan.

Two adult male rats and a female mongrel dog were chosen for distribution studies on methionine; the rats were fasted for 36 hr and then each was fed approximately 1 g of S^{35}-labeled methionine mixed with meat paste; the dog was fasted 48 hr and then given approximately 3.7 g of the labeled methionine by stomach tube. Several series of rats were also used to determine the effective life of S^{35} administered as methionine; the first series consisted of 17 adult rats and received 200 mg of labeled methionine intraperitoneally in distilled water; the second series consisted of 10 young male rats to which a dose of 8 mg of labeled methionine each was administered by stomach tube. All of the animals were anesthetized and exsanguinated and their tissues were prepared for analysis. It was found that the methionine was rapidly absorbed by the animals and S^{35} was present throughout the body within 4 hr. No selective localization of activity was observed; the highest levels occurred in the intestines, pancreas, liver, kidney, and lung.

595 The Effect of Dietary Protein on the Turnover of Phospholipides, Ribonucleic Acid, and Desoxyribonucleic Acid in the Liver. Rosa M. Campbell and H. W. Kosterlitz. J. Biol. Chem. 175, 989-90(1948) Sept. (Letter to the editor).

Experiments are described on the turnover rates of P-containing compounds in rats on low-protein and protein-free diets. A dose of P^{32} (18 to 20 μc) was injected subcutaneously 6 hr before the rats were killed. The ratio of liver phospholipid P^{32}:P^{31} to liver inorganic P^{32}:P^{31} was used as a measure of the turnover rate. From the results it appeared that the total turnover of the phospholipids may be determined by the metabolic needs of the liver and is, within the limits of the experiments, independent of how much of these substances is present in the liver. In prolonged protein deficiency this rule may no longer hold for phospholipid P, a fact which may possibly have some bearing on the development of liver injury in protein deficiency.

BIOLOGY AND MEDICINE

596 The Effect of Succinate on Respiration and Certain Metabolic Processes of Mammalian Tissues at Low Oxygen Tensions in Vitro. Robert F. Furchgott and Ephraim Shorr. J. Biol. Chem. 175, 201-15(1948) Aug.

Experiments were carried out to ascertain the effect of succinate on the respiration of a variety of mammalian tissues in vitro under the low O_2 tensions characteristic of circulatory shock, and to determine the influence of succinate on specific essential metabolic processes, particularly those which require oxidative energy for their maintenance. The following tissues and metabolic processes were investigated: brain (acetylcholine synthesis), liver (urea synthesis), kidney (demmination), skeletal muscle, smooth muscle, and cardiac muscle ("high energy" phosphate resynthesis). In the latter experiment phosphate transfer in slices of dog cardiac muscle was studied at 100 and at 20% O_2 tension. Radioactive phosphorus (probably as $Na_2HP^{32}O_4$) was added as inorganic phosphate. Analyses were made of the concentrations of inorganic phosphate, labile phosphate of adenyl pyrophosphate, and creatine phosphate, as well as of the radioactivity of each fraction. Interpretation of radioactive data indicated a slower rate of synthesis of high energy phosphates at 20% than at 100% O_2, and an even slower rate of synthesis at 20% O_2, in the presence of succinate than in its absence. 24 references.

597 The Effect of Vitamin Deficiencies upon the Metabolism of Cardiac Muscle in Vitro. II. The Effect of Biotin Deficiency in Ducks with Observations on the Metabolism of Radioactive Carbon-Labeled Succinate. Robert E. Olson, O. Neal Miller, Yale J. Topper, and F. J. Stare. J. Biol. Chem. 175, 503(1948) Sept.

Isotopic succinic acid containing C^{14} distributed between its two carboxyl groups and containing about 440,000 counts/min mM was used in studies on the oxidation of succinate in biotin deficient, cured, and control ducks. The O_2 consumption by the ventricles from biotin-deficient ducks in the presence of succinate was found to be decreased below the values found for control birds and was restored by injections of biotin; the $C^{14}O_2$ production from carboxyl-labeled succinate was decreased 55% from that of controls. 37 references.

598 Efficiency of Phosphorylation Coupled to Electron Transport between Dihydrodiphosphopyridine Nucleotide and Oxygen. Albert L. Lehninger and Sylvia Wagner Smith. J. Biol. Chem. 181, 415-29 (1949) Nov.

This paper is concerned with the phosphorus:oxygen (P:O) ratios observed during the DPN-linked (dihydrodiphosphopyridine nucleotide-linked) oxidation of β-hydroxybutyrate to acetoacetate in the same type of enzyme preparation as previously described. Supplementary experiments were performed in which the oxidative phosphorylation took place in the presence of inorganic orthophosphate labeled with P^{32} and unlabeled ATP (adenosine triphosphate) and inorganic pyrophosphate in order to determine more conclusively the role of inorganic pyrophosphate. The P:O ratios consistently observed were about 2.0. It is concluded that all of the phosphorylation which occurred can be attributed to the oxidation of $DPNH_2$ by molecular oxygen, and that the P:O value should be corrected upwards because of dephosphorylation losses by adenylic acid and ATP. The tracer experiments showed that inorganic pyrophosphate is not formed as a phosphorylation product during the course of the oxidation in the liver preparations studied. 17 references.

599 The Enzymatic Equilibria of Phospho(Enol) Pyruvate. Otto Meyerhof and Peter Oesper. J. Biol. Chem. 179, 371-85(1949) July.

The equilibrium of transphosphorylase between adenosine triphosphate (ATP) and pyruvate was determined through the use of labeled (containing C^{14} in the α and β positions) and unlabeled pyruvate; only qualitative results were obtained by this method. A series of measurements with the use of purified transphosphorylase and nonradioactive reactants gave an average value of the equilibrium constant of 1950, corresponding to a ΔF° of -4400 calories (30°C). The equilibria of enolase and phosphoglyceric mutase were confirmed. 26 references.

600 Esterification of Inorganic Phosphate Coupled to Electron Transport Between Dihydrodiphosphopyridine Nucleotide and Oxygen. Morris Friedkin and Albert L. Lehninger. J. Biol. Chem. 178, 611-23 (1949) Apr.

Experiments are described in which P^{32} was used as a tracer to establish the mode of inorganic phosphate transport in enzyme preparations consisting of dilute water suspensions of the washed particulate matter of rat liver; the reactions were carried out in Warburg vessels. The aerobic incubation of $DPNH_2$ (dihydrodiphosphopyridine nucleotide) with the particulate matter and in the presence of ATP (adenosine triphosphate), Mg^{+2}, and cytochrome caused a substantial incorporation of the inorganic phosphate labeled with P^{32} into the esterified phosphate fraction; 80% of the phosphate so bound could be liberated by hydrolysis, indicating that adenine nucleotide was the phosphate acceptor. Anaerobiosis or the absence of one of the above components caused esterification failure, while fluorite increased and arsenite decreased esterification. It is tentatively concluded that the esterification process under consideration accompanies the transport of electrons from $DPNH_2$ to oxygen; no actual esterification sites were located.

601 Fatty Acid Synthesis by Enzyme Preparations of Clostridium Kluyveri. IV. The Phosphoroclastic Decomposition of Acetoacetate to Acetyl Phosphate and Acetate. E. R. Stadtman and H. A. Barker. J. Biol. Chem. 180, 1169-86(1949) Oct.

The role of acetoacetate in butyric acid synthesis by the soluble enzymes derived from Clostridium kluyveri was investigated. Doubly-labeled acetate (C^{14} in the carboxyl and α-carbon atoms) was prepared by the fermentation of glucose in the presence of C^{14}-labeled bicarbonate by anaerobic bacteria; butyric acid, labeled in the carboxyl group with C^{14}, was prepared by the Grignard method. It was found

that when phosphoroclastic decomposition occurred in the presence of the doubly-labeled acetate, almost no isotopic carbon was incorporated into the acetoacetate; the authors conclude that the decomposition of the acetoacetate appears to be irreversible. When carboxyl-labeled butyric acid was oxidized in the presence of inactive acetoacetate, no activity was noted in the acetoacetate and it is concluded that the acetoacetate is not an intermediate in the oxidation of butyrate. Since acetoacetate in hydrogen is reduced quantitatively to β-hydroxibutyrate, and acetate and acetyl phosphate are reduced to butyrate, the acetoacetate, it is concluded, cannot be an intermediate in the synthesis of butyrate by Clostridium kluyveri. 23 references.

602 Fatty Acid Synthesis by Enzyme Preparations of Clostridium Kluyveri. V. A Consideration of Postulated 4-Carbon Intermediates in Butyrate Synthesis. E. R. Stadtman and H. A. Barker. J. Biol. Chem. 181, 221-35(1949) Nov.

Tracer experiments with carboxyl-labeled (C^{14}) butyrate were performed in conjunction with other experiments in order to determine the ability of enzyme preparations of Clostridium kluyveri to oxidize and reduce several 4-carbon compounds which were considered as possible intermediates in the synthesis and oxidation of butyrate. It was found that β hydroxybutyrate, crotonate, and isocrotonate are not oxidized and reduced by the enzyme preparations and do not enter into the butyrate synthesis or oxidation. It was also shown that vinyl acetate is not an obligatory intermediate in the synthesis. Under anaerobic conditions (in a nitrogen atmosphere) tracer experiments demonstrated that vinyl acetate undergoes dismutation (one molecule oxidized, another reduced), oxidation to acetyl phosphate and acetate, reduction in the presence of butyrate (which is oxidized), and oxidation in the presence of acetyl phosphate and acetate (which causes the reduction of the latter two components to butyrate). 13 references.

603 The Formation of β-Carbon of Serine from Choline Methyl Groups. Warwick Sakami. J. Biol. Chem. 179, 495-6(1949) May. (Letter to the editor).

Two male rats were given 5 mM of glycine per 100 g by stomach tube and 0.045 mM of C^{14}-methyl-labeled choline per 100 g cutaneously; the latter dose was repeated at 2 and 4 hr following the original injection. After 14 hr the animals were sacrificed and the serine was isolated from their livers and degraded. The results of the C^{14} analyses indicated that at least one or more of the methyl groups of choline could be converted to formate or a formate derivative and condensed to form the serine; the serine contained high activity, almost all of which was concentrated in the β carbon position.

604 Genetic Differences in Methionine Uptake by Surviving Tissue. Robert Rutman, Everett Dempster, and Harold Tarver. J. Biol. Chem. 177, 491-2(1949) Jan. (Letter to the editor).

Two inbred strains of rats were compared as to their ability to incorporate methionine into surviving liver slices; the

strains differed significantly in body weight and their reciprocal cross offspring showed marked heterosis. Separate pools of liver slices from male and female animals were prepared and incubated in Ringer's solution containing 1.33 μM of methionine labeled with S^{35} at the level of 50,000 counts/min. After incubation, the tissues were heat-denatured, washed, and the methionine content and the radioactivity were determined. There was a large variation in the uptake of methionine at different times and between the strains of animals tested; the standard uptake seemed to increase with age; significantly different amounts of protein were synthesized by the two strains of rats.

605 Heme Synthesis and Red Blood Cell Dynamics in Normal Humans and in Subjects with Polycythemia Vera, Sickle-Cell Anemia, and Pernicious Anemia. Irving M. London, David Shemin, Randolph West, and D. Rittenberg. J. Biol. Chem. 179, 463-84(1949) May.

This report is concerned with studies conducted on two normal subjects, male and female, and on 15 subjects with pernicious anemia, sickle-cell anemia, and polycythemia vera. Glycine labeled with N^{15} was prepared from potassium phthalimide and chloroacetic ester and fed orally hourly over a 48-hr period in equal doses to each of the patients; total dosages of 36.2-48 g of the glycine were given. Samples of venous blood were drawn off at intervals and the hemin content and plasma volume were determined. It was found that the normal survival time of erythrocytes in males is 120 days, and in females, 109 days; subjects with polycythemia vera have normal erythrocyte survival times but greatly increased red cell and hemoglobin production times (about 2.5 times normal). In sickle-cell anemia, it was found that the red cells are destroyed indiscriminately, the average survival being 42 days; an abnormal pattern of red cell destruction and a survival time of 85 days was shown for the pernicious anemia case. The utilization of dietary glycine for the synthesis of the protoporphyrin of hemoglobin was found to be very rapid, labeled cells being released into the blood within a few hours after the injection.

606 Investigations of Human Thyroid Function with the Use of Small Doses of Radioactive Iodine, and the Effect of Thyrotrophic Hormone on I^{131} Uptake and Excretion. M. Reiss, R. E. Hemphill, B. M. Murphy, J. M. Halkerston, and F. E. Badrick. J. Endocrinol. 6, 235-43(1949) Oct.

The gradient of the uptake of small doses (15 μc) of intravenously injected I^{131} by the thyroid was recorded for each of a series of human subjects (normal, chronic psychotic, and hypothyrotic), and the rate of excretion was measured. A method of combining these data for the diagnosis of thyroid disorders is discussed. It was found that thyrotrophic hormone increased the avidity of the thyroid for I^{131} and decreased the excretion rate. It is concluded that the different reactions of hypothyrotic patients to treatment with thyrotrophic hormone can be used for a differentiation between primary (thyrogeneous) and secondary (hypopituitary or cerebral) hypothyrotic cases. 14 references.

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607 Investigation on the Restoration of Dicarboxylic Aminoacids in the Blood, with the Aid of Heavy Carbon C^{13}. A. S. Konikova, M. G. Kritsman, V. N. Orekhovich, S. Ya. Davydova, B. V. Ottesen, M. I. Men'shikov, L. L. Goldin, and G. M. Kukavadze. Doklady Akad. Nauk S. S. S. R. 66, 899-900(1949)(in Russian). (See also NSA 4-7.)

The question whether blood plays an active part in the synthesis and the renewal of proteins was tested with the aid of a C^{13} tracer. Blood of rats and pigeons was incubated in vitro, with $NaHC^{13}O_3$; free dicarboxylic aminoacids were then precipitated, and the proteins hydrolyzed into dicarboxylic aminoacids; CO_2, obtained from both products, was analyzed in a mass-spectrometer for the determination of the isotopic content. The results showed that the following processes take place in the blood: CO_2 fixation, synthesis of aminoacids and restoration of proteins. These processes are more intensive in the blood whose erythrocites have no nuclei (rats) than in the blood with nuclei-containing erythrocites (pigeons).

608 The Measurement of Turnover of the Various Phospholipides in Liver and Plasma of the Dog and Its Application to the Mechanism of Action of Choline. D. B. Zilversmit, C. Entenman, and I. L. Chaikoff. J. Biol. Chem. 176, 193-208(1948) Oct.

An acid-soluble fraction of dog liver, highly concentrated with respect to glycerophosphate, was prepared in order to study the specific activity and properties of glycerophosphate. Use was made of P^{32} and P^{31} in the separation of various phospholipids from one another, in the preparation of radioactive glycerophosphate and in testing and analyzing the various reactions encountered. Biopsy samples were taken from normal and fat-fed dogs at various intervals up to 21 hr after the injection of P^{32} in order to determine the distribution and concentration of total phospholipid P, alkali-stable P and alkali-hydrolyzable, acid-soluble P. The specific activity-time relations of liver lecithin, liver cephalin and liver sphingomyelin were compared with those of the alkali-stable and alkali-hydrolyzable phosphorus fraction. It was found that the specific activity-time relations of a liver fraction met the requirements for a lecithin precursor; choline increased the turnover of the liver lecithin but not of plasma lecithin or of plasma sphingomyelin. It is proposed that choline does not act by increasing fat transport via plasma phospholipids but rather by stimulating the utilization of fats within the liver itself.

609 Mechanisms of Cleavage of Glucose-1-Phosphate. Mildred Cohn. J. Biol. Chem. 180, 771-81(1949) Sept.

The mechanisms of several reactions involving the cleavage of glucose-1-phosphate were investigated with the aid of O^{18}; a method was devised for the analysis of phosphate for its isotopic content. Two types of experiments were carried out: in one type, exemplified by hydrolysis reactions, O^{18} was only present in the water of the medium; in the second type, used in the study of the reversible phosphorylase reactions, the O^{18} was initially present in KH_2PO_4. It was found that in acid hydrolysis, the rupture or cleavage of glucose-1-phosphate occurred between the carbon of glucose and oxygen, but in hydrolysis catalyzed by acid phosphatase or alkaline phosphatase, the bond between the oxygen and the phosphorus was ruptured. The rupture of the bond occurs between carbon and the oxygen of glucose-1-phosphate in both the dephosphorylation reaction and the reverse reaction. Some of the implications of these cleavages on the mechanisms of the reactions are discussed. 17 references.

610 The Mechanism of the Phosphoglucomutase Reaction. Earl W. Sutherland, Mildred Cohn, Theodore Posternak, and Carl F. Cori. J. Biol. Chem. 180, 1285-95 (1949) Oct. (See also NSA 3-2060.)

The mode of participation of glucose-1,6-diphosphate in the transformation of glucose-1-phosphate to glucose-6-phosphate was studied by means of the isotopic tracers, C^{14} (attached to the glucose moiety) and P^{32} (attached to the phosphate radical). It was found that the maximally active glucose-1-phosphate solution was that which also contained 0.03-0.1% of the cofactor α-glucose-1,6-diphosphate. The results of the experiments utilizing the isotopic substrates, crystalline phosphoglucomutase from muscle as enzyme, and nonlabeled glucose-1,6-diphosphate as coenzyme showed that complete equilibrium is established between the various glucose and phosphate moieties. The net effect of the reaction is a continuous interconversion of substrate and coenzyme. 13 references.

611 The Mechanism of the Phosphoglyceric Mutase Reaction. Earl W. Sutherland, Theodore Posternak, and Carl F. Cori. J. Biol. Chem. 181, 153-9(1949) Nov.

The mechanism of the phosphoglyceric reaction (3-phosphoglyceric acid- 2-phosphoglyceric acid) was studied with the aid of 3-phosphoglyceric acid labeled with P^{32}. Spectrophotometric and polarimetric tests were run for enzyme activity on crude dialyzed rabbit muscle extract and enzyme preparation purified by ammonium sulfate fractionation. It was found that the phosphoglyceric mutase, the catalyst for the reaction, in turn requires the presence of catalytic amounts of 2,3-diphosphoglyceric acid; the mode of participation of the diphosphate in the reaction is outlined and the proposed mechanism of the reaction is illustrated diagrammatically.

612 Metabolic Functions of Biotin. II. The Fixation of Carbon Dioxide by Normal and Biotin-Deficient Rats. Patricia R. MacLeod and Henry A. Lardy. J. Biol. Chem. 179, 733-41(1949) June.

The intraperitoneal injection of sodium bicarbonate containing C^{14} (either one dose hourly for 12 times $\cong$.11 mg of 3% active $BaCO_3$, or one 10 mg injection) into normal and biotin-deficient albino rats of the Sprague-Dawley strain resulted in a larger fixation of C^{14} into the adenine, guanine, aspartic acid, citric acid, and bone carbonate of the control animal than into the corresponding compounds of the biotin-deficient animal. The results are discussed in detail. 28 references.

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613 Metabolic Study of the Methyl Groups of Butter Yellow. R. A. Boissonnas, Robert A. Turner and Vincent du Vigneaud. J. Biol. Chem. 180, 1053-8 (1949) Oct.

The synthesis of p-N,N-dimethylaminoazobenzene (DAB) containing C^{14} in the methyl groups was brought about by the methylation of monomethylaminoazobenzene with methyl iodide and sodium in ammonia. The radioactive DAB was fed to a rat on a relatively normal casein diet for 10 days, and the choline and creatinine were then isolated from the carcass of the rat. The radioactivities of the choline and the creatinine (as measured by the creatinine) were found to be negligible, showing no appreciable transmethylation to these compounds. The specific activities of the expiratory carbon dioxide and the urinary urea were found to be the same; the rapid rate of appearance of the radioactivity in the expiratory carbon dioxide indicated the rapid oxidation of the methyl groups. 17 references.

614 The Metabolism of Acetone by Surviving Rat Liver. Ernest Borek and D. Rittenberg. J. Biol. Chem. 179, 843-5(1949) June.

Liver slices from Wistar rats were incubated with deuterio-acetone, oxygen, and Krebs' phosphate buffer in a sealed Krebs flask for 3 hr in order to determine whether acetone is a precursor of cholesterol. The cholesterol was isolated as the digitonide by the usual procedure after the end of the incubation, and was analyzed for its deuterium content. Other experiments were run utilizing normal and deuterio-acetate with the deuterioacetone. It was found that the rat liver slices yielded deuteriocholesterol after incubation, showing that a mechanism exists for the utilization of acetone in the biosynthesis of the cholesterol. It is stated that acetone is apparently not as effective a precursor as acetate; that the acetone is at least partially converted to acetate is suggested by the diminished incorporation of deuterium into cholesterol when normal acetate is added to the reaction system.

615 Metabolism of L-Aspartic Acid. Hsien Wu and D. Rittenberg. J. Biol. Chem. 179, 847-56(1949) June.

L-aspartic acid was synthesized from fumaric acid ammonia containing N^{15} in the presence of Escherichia coli and was fed (0.3 g daily) in a stock diet to each of three rats for three days. It was found that only 1.6% of the N^{15} was excreted in the feces and 43.4% in the urine; 45.5% was retained in the body. Twenty-four hours after the last feeding, the rats were sacrificed and their blood, tissues, and organs were analyzed for the isotope. The concentration of N^{15} was highest in the plasma proteins, and least in the red cell proteins; the stomach, intestines, internal organs, carcass, and skin retained intermediate amounts. Since the isotope content of the urinary ammonia was lower than that of urea, and the isotope content of aspartic acid was lower than that of glutamic acid, it is suggested that aspartic acid is so rapidly deaminated that its metabolic group behaves metabolically like ammonia. 24 references.

616 The Metabolism of Thiocyanate in the Rat and Its Inhibition by Propylthiouracil. John L. Wood and Edward F. Williams, Jr. J. Biol. Chem. 177, 59-67 (1949) Jan.

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The distribution of the thiocyanate ion and its metabolism products was studied in white rats at 6 and 24 hr intervals after the intraperitoneal injection of 25 mg of potassium thiocyanate labeled with radioactive sulfur, S^{35}. The thyroid, adrenals, and portions of the liver and muscle were removed, ground, and analyzed as described. It was found that the protein of the thyroid gland fixes thiocyanate sulfur to a greater extent than the protein of other tissues; this activity is inhibited by propylthiouracil treatment. An accumulation of water-soluble compounds containing S^{35} was found in the thyroid after 6 hr, which increased after 24 hr. These and other experimental findings are interpreted in terms of the metabolic antagonism of thiocyanate for iodide. 20 references.

617 The Metabolism of Yeast Nuclei Acid in the Rat. Paul M. Roll, George Bosworth Brown, Frederick J. di Carlo, and Alfred S. Schultz. J. Biol. Chem. 180, 333-40(1949) Aug.

Two experiments involving the study of nucleic acid metabolism are described: in the first experiment a sample of yeast (pentose) nucleic acid labeled with N^{15} was fed to two male rats over a period of 3 days; and, in the second experiment, a solution of nucleotides, produced by the alkaline hydrolysis of a sample of the isotopic nucleic acid was administered to two male rats intraperitoneally three times daily for three days. In each experiment the compounds were furnished at a level of about 0.4 mM of nucleic acid per kg body weight per day; the urine was collected and used to isolate allantoin, urea, and ammonia. The animals were sacrificed after a one-day interval and their viscera were analyzed for guanine, adenine and mixed pyrimidines, and the percentage of excess N^{15} was determined. The yeast nucleic acid was found to be a precursor of both the purines and the pyrimidines of the nucleic acids isolated from the viscera and it is stated that a material in the nucleic acid may be precursor of the pyramidines of tissue nucleic acids. It was also found that purines of dietary nucleic acid or of injected mixed nucleotides are less extensively utilized for nucleic acid formation than is the free purine adenine. 25 references.

618 The Nature of the Circulating Thyroid Hormone. Alvin Taurog and I. L. Chaikoff. J. Biol. Chem. 176, 639-56(1949) Nov.

The experiments presented here deal with the extractability of plasma iodine and thyroxine added to plasma with butyl alcohol, the similarity of behavior between the thyroid hormone of plasma (labeled with radioiodine I^{131}) and added thyroxine, and the combination of thyroxine with plasma protein. It was found that the iodine of normal plasma was almost completely extractable with butyl alcohol at room temperature; thyroxine added to plasma showed similar properties (extractability with butyl alcohol, retention by butyl alcohol after extraction, not dialyzable). It was observed that protein bound iodine of rat plasma labeled with I^{131} followed thyroxine carrier quantitatively through different media. It is concluded that the data presented supports the theory that circulating thyroid hormone in the normal animal consists of thyroxine bound loosely to plasma protein. 43 references.

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619 On the Occurrence of Monoiodotyrosine in the Thyroid Gland. Alvin Taurog, I. L. Chaikoff, and W. Tong. J. Biol. Chem. 178, 997-8(1949) Apr.

Rats were injected with suitable doses of I^{131} and their thyroids were removed after periods of 10 min, 24 hr, and 48 hr. On pooling of several glands, homogenation with trichloroacetic acid and centrifugation, the soluble residue contained all of the organic iodine; this residue was hydrolyzed, filtered, and analyzed by chromatography and radioautography. Ten minutes after the injection, the monoiodotyrosine had a higher specific activity than the diiodotyrosine, showing that the former probably does not arise from the latter compound; in 24-48 hr, the specific activity of the monoiodosyrosine was less than that of the diiodotyrosine, suggesting that the former is the precursor of the latter. At least 15% of the iodine present in the thyroid gland is concluded to be in the monoiodotyrosine form.

620 On the Metabolic Fate of Pyruvamide and Acetamide. H. S. Anker and R. Raper. J. Biol. Chem. 176, 1353-7(1948) Dec.

The results of the feeding or injection of acetamide(carboxyl-labeled with C^{13}), acetic acid, pyruvic acid, and pyruvamide are presented; the experiments were carried out on rats and rat liver slices. Evidence is presented to indicate that in the intact rat the pyruvamide is split rapidly into acetic acid and formic acid, rather than hydrolyzed to pyruvic acid. It was found that in liver slices pyruvamide could substitute for acetic acid as a precursor for cholesterol and fatty acids; the significance of pyruvamide as a normal metabolite is unknown. Acetamide is only partially and slowly hydrolyzed to acetic acid; the possibility exists that it may acetylate p-aminobenzoic acid without being hydrolyzed.

621 On the Metabolism of $\Delta^{4,5--}$ Cholestenone. H. S. Anker and Konrad Bloch. J. Biol. Chem. 178, 971-6 (1949) Apr.

Deuteriocholestenone (60 mg) was fed to a rat in each of two experiments over a period of three days and the sterols were isolated from the various tissues and excreta. It was found that the labeled cholestenone was well absorbed; the highest isotope concentration was in the saturated tissue sterols, and there is evidence to suggest that this was due to the formation of isotopic dihydrocholesterol; the isotopic concentration of the cholesterol was considerably smaller but significant. It is concluded that cholestenone can be converted to cholesterol but is not an intermediate in the total synthesis of cholesterol, and it is suggested that the dihydrocholesterol normally found in animal tissues is formed from cholesterol by way of cholestenone. 14 references.

622 On the Metabolism of Phenylalanine and Tyrosine. Aaron Bunsen Lerner. J. Biol. Chem. 181, 281-94 (1949) Nov.

In order to verify the theory that ketone bodies are formed as intact 4-carbon bodies in the metabolism of phenylalanine and tyrosine, and to determine the nature of substances other than ketones which might be present, the experiments here

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reported were performed. Use was made of labeled optically active phenylalanine synthesized with C^{14} in the benzene ring and C^{13} in the α carbon atom; labeled, active tyrosine with C^{14} in the β position was also used; the metabolism of these labeled amino acids was determined in rat liver slices. It was found that a major pathway exists in the metabolism under discussion and results in the formation of two intact 4-carbon units, one being a ketone and the other malic acid or its precursor. Two carbon atoms of the benzene ring and two carbon atoms of the aliphatic side chain of the amino acids are converted to ketone bodies; the remaining four carbon atoms of the benzene ring form malic acid. A single experiment with D-phenylalanine showed that this amino acid was metabolized at approximately half the rate of its isomer. 38 references.

623 Orotic Acid as a Precursor of Pyrimidines in the Rat. H. Arvidson, N. A. Eliasson, Einar Hammarsten, Peter Reichard, H. von Ubisch, and Sune Bergström. J. Biol. Chem. 179, 169-73(1949) May.

Two albino rats received 12.5 g of orotic acid (containing N^{15})/100 g of body weight subcutaneously twice a day for 3 days; they were killed 12 hr after the last injection, and the nitrogenous compounds from the liver nucleotides were tested for their content of isotope. The isotope was recovered in uridine and cytidine in 5.4- and 6.9-fold dilution of the administered orotic acid, respectively, whereas the purine ribosides, the purine bases from DNA (desoxypentose nucleic acid), and the proteins contained only insignificant amounts. It is concluded that the orotic acid was utilized for the synthesis of the pyrimidine ring. 16 references.

624 The Oxidation and Distribution of the Methyl Group Administered as Methionine. Cosmo G. Mackenzie, Joseph P. Chandler, Elizabeth B. Keller, Julian R. Rachele, Nancy Cross, and Vincent du Vigneaud. J. Biol. Chem. 180, 99-111(1949) Aug.

A 200 mg dose of L-methionine labeled with C^{14} in the methyl group was given by stomach tube to a rat which had been previously fed a purified diet containing methionine and choline chloride, but no cystine. The rat was placed in a metabolism apparatus and a quantitative collection of carbon dioxide was continued for 52 hr, at the end of which time the animal was exsanguinated, skinned, and dissected, and its organs were measured for radioactivity. Chemical analyses were run also. It was found that the animal was able to oxidize rapidly the methyl group given in the methionine, since one-fourth of the total administered dose appeared in the CO_2 during the first day; the rate was decreased thereafter to a slow and steady value. The administered methyl group also participated in transmethylation reactions, appearing in creatine and choline, and was distributed throughout the body, with highest concentrations in the liver, kidneys, and adrenals. It is suggested that the decrease in the oxidation rate was due to an increased distribution of the methyl group throughout the body and indicated the end of the adjustment period which established equilibrium with the labile methyl pools. 12 references.

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625 Oxidation of Fatty Acids and Tricarboxylic Acid Cycle Intermediates by Isolated Rat Liver Mitochondria. Eugene P. Kennedy and Albert L. Lehninger. J. Biol. Chem. 179, 957-72(1949) June.

The experimental details of laboratory studies on the enzymatic oxidation of fatty acids to acetoacetate and also via the Krebs tricarboxylic acid cycle are presented. Radioactive phosphorus, P^{32}, was used in the experiments studying the activity of subcellular fractions of rat liver in the oxidation of intermediate compounds in the Krebs cycle. It was found that morphologically homogenous mitochondria separated from rat liver dispersions by the hypertonic sucrose method contained essentially all of the measurable activity of the liver in the oxidation of fatty acids; the integrated reactions of the Krebs cycle were also found in this fraction. Esterification of inorganic phosphate accompanied the oxidations, and it was noted that the mitochondria had insignificant glycolytic activity. 31 references.

626 Oxidation of Glucose by Yeast, Studied with Isotopic Carbon. Sidney Weinhouse, Ruth H. Millington, and Katherine F. Lewis. J. Am. Chem. Soc. 70, 3680-3 (1948) Nov.

Experiments on the oxidation of glucose by yeast in the presence of isotopic acetate or bicarbonate (containing C^{13}) lead to the following conclusions: at least half and probably much more of glucose undergoing complete oxidation passes through the intermediate stage of acetate; the tricarboxylic acid cycle is a common pathway for the complete oxidation of both glucose and acetate; intermediates of the fermentation process in yeast are not in equilibrium with acetate; and assimilation of carbon dioxide occurs but is of minor importance in the formation of succinate from glucose. The data are in accord with the postulate that fermentation and oxidation of glucose diverge at acetaldehyde.

627 Phosphoglucomutase. II. Mechanism of Action. Venkataraman Jagannathan and J. Murray Luck. J. Biol. Chem. 179, 569-75(1949) June.

The reaction between the enzyme phosphoglucomutase and glucose-1-phosphate labeled with P^{32} was studied for its mode of action, and it was noted that when the enzyme became radioactive, the activity of the ester P decreased. The acquired radioactivity of the enzyme could not be removed by dialysis even upon denaturation with iodine, but after reaction with an excess of nonlabeled glucose-1-phosphate, the radioactivity was easily dialyzed out. It is proposed that there is direct exchange between the nondialyzed enzyme P and the substrate P during the primary reaction which accounts for the transfer of radioactivity.

628 The Rate of Utilization of Ammonia for Protein Synthesis. David B. Sprinson and D. Rittenberg. J. Biol. Chem. 180, 707-14(1949) Sept.

In order to study the effect of dietary conditions on the utilization of ammonia, a small single dose of ammonium citrate of high N^{15} concentration was administered to both rats and human subjects maintained at various levels of

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nitrogen output. Labeled ammonium citrate (the preparation of which is given) was administered in concentrations of about 0.105 meq for the rats and 1.13-1.41 meq for human subjects; labeled glycine was also administered. On a high protein diet it was shown that ammonia nitrogen was nearly quantitatively excreted, while on a low protein diet an appreciable fraction of the ammonia nitrogen was employed for protein synthesis. The relationship between the isotope concentrations of the urinary ammonia and urea following administration of labeled ammonia or amino acids is discussed. A modified procedure for the preparation of gas samples for mass spectrometric analysis is also presented.

629 Studies on the Mechanism of Aerobic Phosphorylation. J. P. Hummel and Olov Lindberg. J. Biol. Chem. 180, 1-11(1949) Aug.

The phosphate turnover of various nucleotides in a concentrated rabbit liver homogenate during incubation with radioactive orthophosphate was investigated. A method is described for the extraction of the flavin nucleotides, pyridine nucleotides, and adenylic acid from solution after the proteins have been removed; the nucleotides in the experiment were separated by paper chromatography. It was found that flavin mononucleotide, the pyridine nucleotides, and adenylic acid contained no appreciable radioactivity; only adenosine triphosphate and flavin-adenine dinucleotide were uniformly radioactive, the latter showing a high activity. It is suggested that the flavin enzymes may be intimately associated with aerobic phosphorylation. 18 references.

630 Studies on Nitrogen Metabolism in Tomato with Use of Isotopically Labeled Ammonium Sulfate. Robert MacVicar and R. H. Burris. J. Biol. Chem. 176, 511-16(1948) Nov.

A similar article appeared in Am. J. Botany 35, 567-570 (1948) Nov. It was listed in Nuclear Science Abstracts as abstract No. 2-884.

631 Study of Carbon Dioxide Fixation in the Synthesis of Citrulline. Santiago Grisolia and Philip P. Cohen. J. Biol. Chem. 176, 929-33(1948) Nov.

The intermediary role of citrulline in the ornithine, citrulline, arginine cycle of urea synthesis proposed by Krebs and Henseleit was investigated in washed rat liver residue with the use of C^{14}-containing carbon dioxide; citrulline was synthesized from ornithine. It was found that the specific activity of the isolated citrulline was of the same order of magnitude as that of the added $C^{14}O_2$; the conversion of citrulline containing C^{14} in the carbonyl position to urea in liver homogenates resulted in the formation of urea with the same specific activity as that of the added citrulline. It is concluded from the data that, in the system described in this report, citrulline acted as an obligatory intermediate in the urea cycle; citrulline was by far the most active CO_2 fixation reaction present. Attempts at studying the formation of an intermediate carbamyl-glutamic acid derivative were unsuccessful. 21 references.

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632 A Study of the Mechanism of "Phosphotransferase" Activity by Use of Radioactive Phosphorus. Bernard Axelrod. J. Biol. Chem. 176, 295-8(1948) Oct.

An investigation was carried out with the aid of P^{32} in order to determine whether the mechanism of "phosphotransferase" activity consisted of a direct transfer of the phosphate group from the donor to the acceptor compound. When unlabeled p-nitrophenyl phosphate was used as a phosphate donor in the presence of labeled inorganic phosphate, purified citrus phosphatase (which exhibited the "phosphotransferase" activity) and alcohol, the synthesized phosphate ester contained virtually no labeled phosphate; but when the same donor contained labeled phosphate and was used with labeled inorganic phosphate in the presence of alcohol and the "phosphotransferase," the sythesized ester did contain labeled phosphate as active as that present in the donor. It is concluded that in the transfer of phosphate from nitrophenyl phosphate to methanol the transported phosphate does not pass through the inorganic stage.

633 Supplement to the United States Naval Medical Bulletin on Preparation and Measurement of Isotopes and Some of Their Medical Aspects. Published by Bureau of Medicine and Surgery, U. S. Navy, 1948. 215p.

Most of the papers in the Supplement were part of a symposium of the Division of Biological Chemistry of the American Chemical Society in cooperation with the Office of Naval Research at the 1947 New York meeting of the Society. They have been printed through the interest and cooperation of the Editor of the Naval Medical Bulletin, Dr. Louis H. Roddis, as the March-April 1948 Supplement to the Naval Medical Bulletin. The introduction of the supplement, which contains a short review of the historical development of the applications of isotopic indicators and some remarks of general interest, is written by Harold C. Urey. Included are papers on isotope separation, pile and cyclotron production of isotopes, mass spectrometry, radioautographic technic, etc.

634 The Synthesis of Glutathione in Cell-Free Pigeon Liver Extracts. Robert B. Johnston and Konrad Bloch. J. Biol. Chem. 179, 493-4(1949) May (Letter to the editor).

It was shown that glutathione synthesis, as measured by the incorporation of C^{14}-glycine, proceeded rapidly in the supernatant fluid of pigeon liver homogenates which had been centrifuged previously at 2000 gravity for 10 min; enzyme activity was also found when saline-bicarbonate extracts of acetone-dried pigeon liver were examined. Adenosine triphosphate was shown to be essential to the system, while ammonium chloride in low concentrations was found to decrease the activity of the system; since glutamine only partially replaced glutamic acid in the system, it is concluded that glutamine is not an intermediate in the glutathione synthesis.

635 The Synthesis of Glutathione in Isolated Liver. Konrad Bloch. J. Biol. Chem. 179, 1245-54(1949) July.

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This report describes some in vitro experiments which were carried out concerning the formation of glutathione in broken cell preparations and with the aid of radioactive N^{15} and C^{14} preparations. DL-glutamic acid was labeled with N^{15}, and carboxyl labeled glycine ($NH_2CH_2C^{14}OOH$) was also synthesized; labeled glutathione, prepared by the incubation of rat liver slices and homogenates with the isotopic glycine or glutamic acid, demonstrated the synthesis of the tripeptide under in vitro conditions. N-acetylglycine was also utilized for glutathione formation in liver slices but not homogenates; adenosine triphosphate was used to accelerate the aerobic synthesis in liver homogenates, and to some extent anaerobic synthesis. 28 references.

636 The Use of Antipyrine in the Measurement of Total Body Water in Man. Robert Soberman, Bernard B. Brodie, Betty B. Levy, Julius Axelrod, Vincent Hollander, and J. Murray Steele. J. Biol. Chem. 179, 31-41(1949) May.

Antipyrine and deuterium oxide were compared for their distribution within the bodies of normal and abnormal human subjects, their toxicity, excretion rates and accuracy in measuring tissue and total body water content. Preliminary experiments were made on dogs, and the main experiments consisted of administering intravenously 1 g doses of antipyrine and 50 g doses of deuterium oxide to 8 normal subjects, and 7 abnormal subjects with cirrhosis and ascites (3), nephritis and edema (2), and compensated congestive failure with ascites and edema (2). It was found that the antipyrine was uniformly distributed in the various tissues in close proportion to the water content, its excretion was negligible and it was metabolized only slowly; the distribution values for the deuterium oxide and the antipyrine in both normal and abnormal subjects agreed well. It is concluded that ease of analysis and nontoxicity make antipyrine a satisfactory substance for use in the measurement of total body water; the only complications arise in connection with plasma protein binding and slow metabolism.

637 The Utilization of Acetate for the Synthesis of Fatty Acids, Cholesterol and Protoporphyrin. L. Ponticorvo, D. Rittenberg, and Konrad Bloch. J. Biol. Chem. 179, 839-42(1949) June.

Five growing rats were kept on a lipid-free diet to which was added 1 mM of sodium deuterioacetate per 100 g of weight per day; the rats were sacrificed 29-158 days after the beginning of the experiment, and the fatty acids and cholesterol digitonide were isolated from the rat livers and hemin from blood by the usual procedures. Two days before the end of the experiment, the last rat was given 150 mg of β-phenyl-DL-α-aminobutyric acid, and phenyl-L-acetamidobutyric acid was isolated from the urine, containing 0.266 at.% deuterium excess. The isotope concentrations in the fatty acids and cholesterol indicated that 20 and 45%, respectively, of the carbon atoms of these compounds were derived from acetate; about one-third of the hydrogen atoms of hemin was derived from the hydrogen atoms of the methyl group of the acetic acid. The life span of the erythrocyte of the rat is estimated as 100 days.

638 The Utilization of Glycine in the Biosynthesis of Hemoglobin. Moises Grinstein, Martin D. Kamen, and Carl V. Moore. J. Biol. Chem. 179, 359-64 (1949) May.

Two healthy dogs and one rat were fed glycine labeled with C^{14} in the carboxyl group in order to show that the carboxyl carbon of the glycine is used for the biosynthesis of globin but not protoporphyrin, to determine whether globin within the red cell participates in protein interchange, and to discover whether coproporphyrin, isolated from the urine and feces after the tagged glycine was fed, would contain C^{14} even if the hemoglobin protoporphyrin did not. The radioactive substance was administered by stomach tube to each of the dogs in three divided doses over 27 hr and 3 days after the erythrocyte content had been lowered by continued bleeding; the total doses were 50 and 100 g, and samples of blood were taken at intervals for 110 and 153 days. One white rat was kept on a protein-free diet and then fed 200 γ of the labeled glycine by stomach tube in four divided doses over 3 days; 20 days later the animal was bled to death and the blood was analyzed. It was found that: the carboxyl carbon of glycine is incorporated in globin and not protoporphyrin; globin within the intact erythrocyte does not participate in protein interchange; and, since coproporphyrin-1 isolated from the feces of one animal following the administration of the labeled glycine showed no radioactivity and because of other findings, the concept that copropophyrin-1 is a by-product of protoporphyrin-1X formation is supported. 14 references.

639 Chemical Measurement of Ionizing Radiations. M. J. Day and Gabriel Stein. Nature 164, 671-2 (1949) Oct. 15 (Letter to the editor).

Experiments are described whereby radiation absorption in aqueous solutions is accurately measured by chemical means. Benzene and sodium benzoate are used as "acceptors" for hydrogen and hydroxyl radicals formed by ionizing radiations in aqueous solutions. These compounds are hydroxylated with the formation (among other substances) of phenolic Folin's reagent added directly to the irradiated solution. Work is normally carried out in the presence of air, which gives a yield directly proportional to the dose up to about 60,000 r, after which the reaction proceeds with decreased yield in the virtual absence of oxygen. Yields are not critically dependent on pH, concentration or temperature. The method is suggested for use in biological work since it would be preferable, theoretically, to measure effects produced in media similar in composition to living tissue than to measure in the usual terms of the ionization produced in air.

640 Colchicine, X-rays and the Mutation Process. Ake Gustafsson and Nils Nybom. Hereditas 35, 280-4 (1949).

A special strain of Ymer barley seed was tested for the effects of irradiation and colchicine. Twenty-four hr before irradiation, seeds were set to germinate in five different colchicine solutions of 0.1, 0.05, 0.005, 0.01, and 0.001% strength; the x-ray dosages were 5,000, 10,000, and 15,000 r. It was found that the four highest concentrations of colchicine

caused a complete mitosis, while the lowest concentration was ineffective. From the results it is concluded that: the course of the mutation process is considerably altered by the application of colchicine previous to the irradiation; the xantha and alboviridis types, as well as very rare mutants, increase in number as a result of such a pretreatment; the viridis mutants become rarer; and, the different groups of mutation, at least with regard to albina, xantha, and viridis types, show a conspicuous connection with the sterility conditions of the ancestor plants.

641 The Influence of the Y-chromosome on X-ray Induced Mutation Rate in Drosophila Melanogaster. Jean Kerschner. Proc. Natl. Acad. Sci. U.S. 35, 647-51 (1949) Nov.

The experiments described were performed in order to determine the effect of an extra Y-chromosome on x-ray induced visible and sex-linked recessive lethal mutation frequency in Drosophila melanogaster. A medium-voltage (135 kv) therapy machine was used with no filter at a target distance of 17 cm and at an average output of 450 r/min; the total dosage was 2,000-4,000 r. The extra Y-chromosome, when present, was shown to decrease x-ray induced visible and sex-linked lethal mutation frequency in the male fly; in the female, it appeared to be without effect. The possible mode of action of the Y-chromosome was discussed and future lines of investigation were proposed.

642 Mutant Strains of Escherichia Coli Unable to Synthesize p-Aminobenzoic Acid. J. O. Lampen, M. J. Jones, and R. R. Roepke. J. Biol. Chem. 180, 423-34(1949) Aug.

Three mutant strains which were produced (273-384, 45-462, and 1861-460) by the irradiation of Escherichia coli and which were grown in the presence of p-aminobenzoic acid (PABA) were tested for survival in other media, favorable and unfavorable. The mutant 273-384 was first isolated from a single colony culture of E. coli irradiated at 40 kv, by the use of a copper target for 4 hr during growth in Difco A. C. broth at 30°C. The mutants 1861-460 and 45-462 were isolated from resting cell suspensions irradiated at 40 kv for 2 hr at 12-15°C. It was shown that the addition of a mixture of purines and amino acids reduces the concentration of PABA needed to produce half maximal growth, and that the PABA can be replaced by a combination of amino acids, a purine, and thymine, although growth is not optimal; methionine is an essential amino acid ingredient but cannot replace the entire mixture; the point of action of PABA in the synthesis of methionine is discussed. Mutant 273-384 and the parent strain are highly resistant to the sulfonamides when growing in the presence of the purines, thymine and a mixture of amino acids; variants of 273-384 may require only one of the three ingredients essential to the 273-384; mutant 45-462 appears to be similar to 273-384, while mutant 1861-460 appears to be similar to the variants of 273-384. 22 references.

643 Studies on X-ray Mutations in the White and Forked Loci of Drosophila Melanogaster. II. A Study of the

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Formation of Gynandromorphs and Other Kinds of Mosaics. G. Bonnier, K. G. Lüning, and Ann Margret Perje. Hereditas 35, 301-35(1949). (See also NSA 3-14.)

This paper discusses certain aspects of the formation of mosaics of different kinds after x-irradiation of wild males of Drosophila Melanogaster. A study was made of the 140 gynandromorphs occurring after crossing yellow white singed females to wild males irradiated with 2,908 r; cases with small female (wild type) areas isolated within male areas were especially investigated. Cases of gynandromorphs with sexcombs on wild-type forelegs are described; other results are summarized, and the results of a previous investigation are reviewed. 23 references.

644 The Beta-Gamma Surface Dosage Rate from Natural Uranium. Ben Kalmon. AECD-2748, Aug. 22, 1949, Decl. Nov. 28, 1949. 6p.

An experimental determination has been made of the β-γ dosage rate at the surface of a natural uranium disc. The measurements were made with a Ryerson electrometer and an extrapolation ionization chamber. The average value so obtained is 246.5 mrep/hr $\pm$ 5%.

645 Precautions for Workers Using Radioactive Isotopes. G. H. Guest. National Research Council of Canada Report No. NRC-1878, June 15, 1948. 11p. (Also published in Can. J. Comp. Med., Dec. 1948).

Radioactive isotopes have been made available from Chalk River for use by Canadian biologists. Experience has shown that the handling of radioactive isotopes may involve health hazards unless adequate precautions are taken. The nature of these hazards and the type of precautions which must be taken when working with radioactive isotopes are considered. Successful work with radioactive isotopes other than in the smallest tracer amounts requires the use of laboratories and equipment especially designed for the purpose, and this is dealt with briefly. The operation of a radioactive laboratory requires certain auxiliary equipment and services, such as health instruments, film monitoring, special laboratory clothing, special cleanable surfaces, and disposal of radioactive waste materials. These topics are discussed briefly. Handling of radioactive isotopes involves certain special precautions and a few of these, such as protection of hands, cleaning of glassware, handling of solutions, etc., are reviewed. In addition to protecting all personnel in a laboratory from harmful amounts of radiation, it is necessary to keep the laboratory and the building in which it is housed as free as possible from radioactive substances and this important fact has been stressed.

646 Safe Handling of Radioisotopes. G. G. Manov and D. O. Lintz. Mech. Eng. 71, 991-8, 1030-31(1949) Dec.

The different types of radiation are discussed along with the various instruments used for detecting it. Several tables and graphs are given showing the following: the maximum permissible exposure used at Oak Ridge, permissible working distance in feet of unshielded sources, permissible working time in minutes within one foot of various quantities of Na^{24} shielded or unshielded, and typical shielding requirements for 10 mc of various isotopes. Some typical manipulators are illustrated and described. The methods of surveying and detecting contamination are also presented.

647 Roentgen Therapy for Pituitary Adenoma. Correlation of Tumor Dose with Response in 64 Cases. Arnold L. Bachman and William Harris. Radiology 53, 331-41(1949) Sept.

The results of the radiation therapy of 64 cases of pituitary adenoma are presented. Of these cases, 38 were chromophobic, two were eosinophilic, and five were basophilic; radiation therapy was the primary treatment in 61 of the cases while 13 patients later received surgery; three cases received surgery primarily and radiation therapy postoperatively. The irradiation course was carried out at 180-200 kv, through 0.5 mm Cu and 1 mm Al Thoraeus filtration, and at a target distance of 50-60 cm; the total tumor dose was around 1,000 r to about 3,000-4,000 r. Usually three pituitary fields were employed, the frontal, right temporal, and left temporal; occasionally para-frontal, superior, and mastoid fields were used. Distinct improvement was obtained in 58% of the chromophobic adenomata cases, 43% of the eosinophilic cases and 80% of the basophilic adenomata cases. It is shown that increasing dosages resulted in a greater incidence of improvement, and that the single course therapy resulted in earlier benefit that the multiple course therapy and with lower total dosage. It is concluded that optimal therapy in these cases would probably be 3,000-4,000 r delivered in 30-45 days, for cases of average severity; surgical intervention would be employed if unsatisfactory results occurred. A second series of radiation therapy would be indicated for cases resulting in improvement, followed by recurrence of the disease. The need for further studies on the effects of radiation therapy and the optimal dosages expected in cases of advanced bone destruction is emphasized. 13 references.

648 Factors Influencing the Effectiveness of Radioiodotherapeusis. Robert H. Williams, Herbert Jaffe, Beverly T. Towery, Walter F. Rogers, Jr., and Rene Tagnon. Am. J. Med. 7, 718-30(1949) Dec.

An attempt was made to correlate the dosage of isotope used with the results in the treatment of 11 patients with thyrotoxicosis in order to determine the minimal effective dosages in such cases; earlier estimations of amounts of the isotope in the blood, urine, or thyroid regions after specific intervals and clinical examinations and estimations of the thyroids were also correlated with the results. It was found that none of the methods of estimation was entirely satisfactory, although the clinical evaluation of the thyroid was of some help. Previous therapy with thiouracils for long intervals or with thyroidectomy affected the minimum amounts of radioiodine required for the elimination of the thyroid conditions. The value of the administration of propylthiouracil before, and of potassium iodide after radioiodotherapeusis is discussed; other factors affecting the results of the therapy are also covered. 11 references.

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649 The Development of Linear Accelerators in Synchrotrons for Radiotherapy and for Research in Physics. John Cockcroft. Proc. Inst. Elec. Eng. 96, Part I, 296-303(1949) Nov.

The article contains a simplified explanation of the operation of the synchrotron and of the linear accelerator, and a short discussion of their applications to radiotherapy. Details of the operation of several of these machines are described. The author concludes with a paragraph on the proton synchrotron and the synchro-cyclotron.

650 Further Studies on the Effect of Irradiation Therapy for Carcinoma of the Cervix Upon the Urinary Tract. Houston S. Everett, C. Bernard Brack, and George J. Farber. Am. J. Obstet. Gynecol. 58, 908-19(1949) Nov.

Thirty-three patients were studied for the effects of irradiation therapy on the urinary tract. The patients had been previously irradiated for cervical carcinoma by the application of two doses of radium of 2,400 mg hr each (with a two-week rest interval) delivered by 100 mg of radium element, followed by a total dosage of 8,000 r of x-radiations delivered by individual doses of 200 r (two or three times a week) to each of two fields. It is concluded from the study that the early detection of such irradiation damage as occurred in the patients described makes possible appropriate treatment before the ureteral obstruction endangers the life of the patient. Radium is considered potentially more dangerous than x-ray therapy; the danger may be reduced by achieving the desired mg hr dosage with smaller amounts of radium over longer periods of time.

651 Carcinoma of the Eyelid. Analysis of 301 Cases and Review of the Literature. Charles G. Stetson and Milford D. Schulz. New Engl. J. Med. 241, 725-32 (1949) Nov. 10.

Three hundred and one cases of carcinoma of the eyelid are presented and the various methods of primary treatment of the disease are evaluated and reviewed. In 76% of the entire group, irradiation treatment was used; the majority of 23 patients treated with 100 kv, received a single large dose. Of the 11 treated with 200 kv at a target distance of 20 cm, 75% were given a single large dose and 25% fractionated doses; the effective tumor dose was about 3,000 r. When radon was applied topically, the average skin dose was 3,275 γ r. Seventy-one patients were treated surgically (electrosurgery or excision). The cure rate was 97-100%, including those cases which necessitated secondary treatment. Some complications after irradiation are discussed; the most frequent of these was stenosis of the tear duct when lesions involving the inner canthus and medial portions of the lids were treated. Severe deformity of the lids and persistent chronic, painful conjunctivitis are other complications discussed. 24 references.

652 Roentgen Therapy of Thrombophlebitis. Claude R. Snead, Jack Lasner, E. L. Jenkinson, and Geza de Takats. J. Am. Med. Assoc. 141, 967-9(1949) Dec. 3.

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The results of the treatment of 100 consecutive cases of thrombophlebitis of the lower extremities by roentgen therapy are presented. The radiations were delivered at 200 kv and at a focal distance of 50 cm with a medium Thoraeus filter; most of the patients received a short course of 1-6 doses of 80 r (in air). The lesions treated were classified into the following types: acute superficial, acute collateral, and migrating phlebitis, recurrent thromboses of the muscles of the calf, iliofemoral venous obstructions, and recurrent phlebitic indurations. The object of the therapy was to throttle or abort the acute lymphatic obstruction or lymphatic hyperplasia surrounding the thromboses segment of the vein. The results show that 85% of the cases reacted favorably to the treatment; in 9% of the cases, the results were doubtful. It is stated that the thrombosis itself must be treated by other methods, such as anticoagulants, division of the veins, or the use of a sympathetic block.

653 Results of an Experimental Therapy of Carcinoma of the Cervix. J. L. McKelvey, K. W. Stenstrom, and J. S. Gillam. Am. J. Obstet. Gynecol. 58, 896-904(1949) Nov.

The results of a method of irradiation treatment for carcinoma of the cervix are described; the method consists of the diffuse x-irradiation of the pelvic region with a total dosage of 3,000 r delivered in daily doses over a period of about 28 days, and followed immediately by the insertion of radium needles for a total dose of up to 5,000 mg hr over a period of 100 hr. The x-rays were delivered by a 220 or 400-kv machine with a filtration of 1 mm Cu and 1 mm Al or of 0.25 mm Cu, 1 mm Al and 0.44 mm Sn; the target distance was 60-80 cm. As a rule, five fields (anterior, left lateral, right lateral, posterior left oblique, and posterior right oblique) were used, one field being treated each day with a dose of 300-350 r in air. With the radium technique, up to five needles were inserted, two in intrauterine portals in tandem and three in vaginal portals. The five year cure rates are as follows: the average, 53.6%; stage I, 80.2%; stage II, 54.1%; stage III, 29.5%; and stage IV, one out of 16 patients. It is concluded that the techniques described are an improvement over previous methods since higher cure rates were obtained.

654 A Study of 135 Cases of Carcinoma in Situ of the Cervix at the Free Hospital for Women. Paul A. Younge, Arthur T. Hertig, and Dorothy Armstrong. Am. J. Obstet. Gynecol. 58, 867-92(1949) Nov.

A study is presented concerning 135 cases of carcinoma in situ of the cervix; the incidence, symptoms, appearance, diagnosis, clinical course, and methods of treatment of the disease are discussed and a review of the literature is included. Irradiation therapy was the primary method of treatment in 20 of the cases and consisted of any one of the following techniques: radium implantation after supervaginal hysterectomy; radium implantation alone; radium implantation and x-irradiation; or cauterization and x-irradiation. Six of the patients are dead after five years, three from other maladies, one from a recurrence of the cervical carcinoma and two from complications developing as a result of the irradiations. 23 references.

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655 Geochemical Regularities in Mendelyeev's Table. S. L. Polushkin. Priroda No. 7, 43(1949)(in Russian).
In a short note, with no illustrative examples or a reference to a more explicit work, the author gives the following rule: the atomic numbers of geochemically related elements form repetitions of the sequence of numbers 2, 8, 18, and 32, i.e., the series 2×1^2, 2×2^2, 2×3^2, and 2×4^2. These numbers are the same that form periods in Mendelyeev's table.

656 Report of Committee on Atomic Weights. G. E. F. Lundell. J. Am. Chem. Soc. 71, 1141-2(1949) Apr.
This is a survey of work which has been reported since material was gathered for the report which was published in Chem. Eng. News 26, 1619(1948). The following have been determined: the isotopic constitution for Ce, La, Nd, and Pr; the isotopic composition of Sa; and the relative abundances of the isotopes of Cd and Zn.

657 "Special Zones" in the Periodic Table of the Elements. M. A. Levitskaya. Doklady Akad. Nauk S.S.S.R. 64, 61-3(1949)(in Russian). (See also NSA 2-1232.)
It is known that at certain values of Z the electronic energy levels undergo perturbations reflected in the breaks on Moseley's diagrams and in the irregularities in the filling of the orbits along the periodic table. A correspondence is shown between these phenomena and the "special zones" in the table, which have been studied by the author (Doklady Akad. Nauk S.S.S.R. 55, 309(1947); 60, 45(1948); 61, 55(1948)) The relationship is clearly seen on curves giving the energy variations of the K and L levels, as a function of Z; within the limits of each special zone, the orbit energy passes through a minimum. The cause of all these changes in the orbits should be traced to changes within the nucleus; thus, it seems probable that a decrease in the energy of an orbit, for a certain value of Z, corresponds to a decrease of the mass defect, i.e., to a relaxation of the nuclear binding forces. As a quantitative description of these relationships, it can be tentatively advanced that the ratio between the increase of the nuclear energy and the decrease of the orbital energy is approximately equal to the ratio between the radii of the orbit and of the nucleus.

658 The Chemistry of Ruthenium. Donald D. Deford. University of Kansas. May 1948. 176p. (NP-1104).
The author states that this dissertation serves the twofold purpose of presenting a complete and critical survey of the literature on the chemistry of ruthenium and of reporting the results of the original investigations that he carried out. A brief survey of the chemistry of ruthenium is presented in Chapter II. It is intended that this chapter provide the reader with a sufficient background in the general chemical behavior of ruthenium to facilitate understanding and correlation of the detailed information presented in later chapters. The review of the chemistry of ruthenium is continued in detail in Chapters III to XI, inclusive. An attempt has been made to make this review as critical and as complete as possible, and original references are cited for statements that are made. In general, the observations of the author

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have been included at appropriate places in the review. The author states that his work on the cyanide complexes of ruthenium is sufficiently extensive to warrant a separate chapter. The results of this investigation are reported in detail in Chapter XII. A complete survey of analytical methods for ruthenium is presented in Chapter XIII, and the colorimetric method of analysis which was developed by the author is discussed in Chapter XIV.

659 Heat Capacities at Low Temperatures and Entropies of Vanadium Carbide and Vanadium Nitride. C. H. Shomate and K. K. Kelley. J. Am. Chem. Soc. 71, 314-15(1949) Jan.
The heat capacities of vanadium carbide and vanadium nitride were measured throughout the temperature range 50.4 to 298.16°K. The entropies of vanadium carbide and nitride are, respectively, $S^\circ_{298.16} = 6.77 \pm 0.03$ and $S^\circ_{298.16} = 8.91 \pm 0.04$. The corresponding entropies of formation from the elements are $\Delta S^\circ_{298.16} = -1.6 \pm 0.1$ and $\Delta S^\circ_{298.16} = -21.0 \pm 0.1$.

660 High Temperature Heat Contents of Vanadium Carbide and Vanadium Nitride. E. G. King. J. Am. Chem. Soc. 71, 316-17(1949) Jan.
High temperature heat contents above 298.16°K of vanadium carbide and vanadium nitride were measured from about 400° to 1611°K. A table of heat content and entropy increments above 298.16°K is reported, and heat content and heat capacity equations are derived.

661 The Kinetics of the Thallium(I)-Thallium(III) Exchange Reaction. René J. Prestwood and Arthur C. Wahl. J. Am. Chem. Soc. 71, 3137-45(1949) Sept.
Studies of the kinetics of the thallium(I)-thallium(III) exchange reaction are described. It was found that the rate of exchange was greater in nitric acid than in perchloric acid, increased with increasing nitric acid concentration (1.0-1.5 f.), and decreased with increasing perchloric acid concentration (1.5-3.5 f.). The presence of platinum black in the exchange solution caused a marked increase in the exchange rate; the presence of finely divided silica gel caused no measurable change in the rate. Four precipitation methods for the separation of Tl(I) and Tl(III) were studied. All caused measurable and reproducible apparent zero-time exchanges due to coprecipitation or separation-induced exchange or both. It was found that separation-induced exchange was the predominant effect for at least two of the methods studied. The following expression is derived which relates F, the fraction exchange that occurs in solution in time t, to F′, the observed fraction exchange at time t, and F_0', the observed fraction exchange at time zero (apparent zero-time exchange).

$$F = (F' - F_0')/(1 - F_0')$$

This expression is valid as long as the separation-induced exchange and the degree of separation are reproducible in a given exchange run. Formulas are given for the determination of the exchange rates.

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662 Low-Temperature Heat Capacity and High-Temperature Heat Content of Ammonium Vanadate. S. S. Todd and J. P. Coughlin. J. Am. Chem. Soc. 71, 317-19(1949) Jan.

The low temperature heat capacity of ammonium vanadate was measured throughout the temperature range 51.4 to 298.16°K. The entropy is $S^{\circ}_{298.18} = 33.6 = 0.3$ cal/degree/mole. The high temperature heat content of ammonium vanadate was measured throughout the temperature range 298.16 to 550°K. Thermal decomposition precluded obtaining satisfactory results at higher temperatures. Heat content and entropy increments above 298.16°K are tabulated.

663 Quantitative Inorganic Paper Chromatography; Sub-Micro Separation and Determination of Aluminium, Iron, and Titanium. A. Lacourt, G. Sommereyns, E. Degeyndt, J. Barugh, and J. Gillard. Metallurgia 40, 181-2(1949) July.

This article appeared as a letter to the editor in Nature 163, 999-1000(1949) June 25. It appeared in Nuclear Science Abstracts as abstract No. 3-1335.

664 Carrier-free Radioisotopes from Cyclotron Targets. VII. Preparation and Isolation of V^{48} from Titanium. Herman R. Haymond, Roy D. Maxwell, Warren M. Garrison, and Joseph G. Hamilton. AECU-623 (UCRL-473), Sept. 1949. 4p.

This is not an abstract; the document is reproduced below in its entirety.

V^{48} can be prepared (H. Walke, Phys. Rev. 52, 777(1937)) by the reactions $Ti^{47}(d,n)V^{48}$ and $Ti^{48}(d,2n)V^{48}$. The present paper reports a chemical procedure used in isolating carrier-free V^{48} from a titanium target which had been bombarded with 19-Mev deuterons in the 60-in. cyclotron at Crocker Laboratory. The carrier-free V^{48} was separated from the target element and from milligram amounts of calcium and scandium which were added as hold-back carriers for the radioisotopes (G. T. Seaborg and I. Perlman, Rev. Mod. Phys. 20, 585(1948)) produced concurrently by the reactions; $Ti^{48}(d,\alpha p)Ca^{45}$, $Ti^{48}(d,2p)Sc^{48}$.

The Ti target (C.P. metal powder supported on a copper target plate with 0.25 mil Ta foil) was bombarded for 200 μa-hr. at a maximum beam intensity of 20 μa. After aging for 24 hr, the Ti powder (approximately 1 g) was dissolved in a minimum volume of 36N H_2SO_4 and the solution was evaporated to dryness. 5.0 g of Na_2CO_3 and 0.1 g of $NaNO_3$ were added and the mixture was fused at 500°C for 30 min. The sub-micro amount of V^{48}, presumably as vanadate, was extracted from the insoluble titanium oxide by repeated washings with cold water. To remove any Ca and Sc activities which may have been extracted with the V^{48}, the solution was acidified with HCl, 10 mg of Ca and Sc were added and precipitated from 1M Na_2CO_3. The supernatant containing the V^{48} was neutralized with 12N HCl and evaporated to dryness. The V activity was separated from most of the NaCl by extraction with approximately 5 ml of 12N HCl. The HCl solution containing the activity and milligram amounts of NaCl was evaporated to dryness and diluted with water to give an isotonic saline solution of carrier-free V^{48} which was used in biological tracer studies.

The V^{48} was identified by the assigned (W. C. Peacock and M. Deutsch, Phys. Rev. 69, 306(1946)). 16-day half-life and by the 0.7-Mev positron and 1.33-Mev gamma ray which have been reported (H. Walke, Phys. Rev. 52, 777(1937)). Chemical separations with added Ca, Sc, Ti, and V carriers further identified the activity as V^{48}.

665 Carrier-free Radioisotopes from Cyclotron Targets. VI. Preparation and Isolation of $Ag^{105,106,111}$ from Palladium. Herman R. Haymond, Kermit H. Larson, Roy D. Maxwell, Warren M. Garrison, and Joseph G. Hamilton. AECU-624(UCRL-472), Sept. 1949. 4p.

This is not an abstract; the document is reproduced below in its entirety.

Radioactive silver, produced by bombardment of palladium with 19-Mev deuterons, has been isolated without added isotopic carrier. Four long-lived radioisotopes of silver (G. T. Seaborg and I. Perlman, Rev. Mod. Phys. 20, 585 (1948)) are produced in a thick target by (d,n) and (d,2n) reactions with deuterons of this energy: 45-day Ag^{105}, 8.2-day Ag^{106}, 225-day Ag^{110}, and 7.5-day Ag^{111}. Radioactive rhodium and radioactive ruthenium are also produced by (n,p) and (n,α) reactions, respectively. The carrier-free radiosilver was separated from the target element and from the radioisotopes of rhodium and palladium by a precipitation technique using mercurous chloride as the coprecipitant.

A C.P. palladium metal target (1/4-in. Pd strip, soldered to a water-cooled copper plate with a silver-free hard solder) was bombarded with 19-Mev deuterons for a total of 200 μa-hr at an average beam intensity of 20 μa. The irradiated surface was milled off (approximately 0.5 g of Pd) and dissolved in aqua regia. The solution was evaporated to dryness and dissolved in 500 ml of 0.5N HCl containing 50 mg each of rhodium and ruthenium hold-back carrier.

0.5 ml of a saturated solution of mercurous nitrate was added while the solution was stirred vigorously. The precipitate of Hg_2Cl_2 containing over 95% of the radiosilver was centrifuged, washed with 0.5N HCl, and dissolved in a minimum volume of 16N HNO_3. 200 mg of Na_2SO_4 were added and the solution was evaporated to dryness in a porcelain dish which was then heated to 450°C for 2 hr to drive off the mercury carrier. The activity was quantitatively soluble in 10 ml of distilled water to give an isotonic saline solution of carrier-free radiosilver which was used in subsequent biological experiments.

The radiosilver was identified by half-life determinations, absorption measurements, and by chemical separation with carrier. The decay was followed for 200 days and showed the approximately 8-day (J. D. Kraus and J. M. Cork, Phys. Rev. 52, 763(1937); M. L. Pool, Phys. Rev. 53, 116(1938)) period of $Ag^{106,111}$ and the 45-day (T. Enns, Phys. Rev. 56, 872(1939)) period of Ag^{105}. One month after bombardment the activity showed only the 45-day period. After 150 days the decay curve began to level off, presumably into the

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225-day (J. J. Livingood and G. T. Seaborg, Phys. Rev. 54, 88(1938)) period of Ag^{110}; aluminum absorption measurements one week after bombardment showed the approximately 1.0 Mev beta particle previously reported (N. Feather and J. V. Dunworth, Proc. Roy. Soc. (London) A 168, 566 (1938)) for Ag^{108} and Ag^{111}; a tracer amount of activity added to a solution of Pd, Rh, Ru, and Ag in carrier amounts was quantitatively precipitated with the AgCl fraction.

666 An Attempt to Separate Radioactive Rare Earths of the Cerium Group by Ion Migration. Roland Lindner. Z. Naturforsch. 4a, 155(1949) May (Brief report, in German).

The applicability of the method of separating radioactive rare earths by ion migration in aqueous solution was investigated. Irradiated uranium served as source of the radioactive rare earths used, which were La^{140}, Ce^{144}, and Pr^{143} which were detected by the different half-lives of their respective activities. Platinum wires were used as electrodes. The separation took place in glass tubes 6.5 mm in diameter, water-cooled from the outside to a temperature of 14°C. Starting with an initial ratio of 50:50, the final ratios achieved were 47:53 for La/Ce, and 45:55 for La/Pr.

667 The Spectrochemical Analysis of Radioactive Solutions. Cyrus Feldman, Myron V. Hawkins, Marvin Murray, and Donald R. Ward. AECD-2757, Nov. 23, 1949, Decl. Dec. 13, 1949. 18p.

A description is given of a chamber designed to permit electrodes for spectrochemical analysis to be loaded outside the spectrographic laboratory, excited with spark or other intermittent excitation, and disposed of with a minimum risk to personnel. If strippable films are used to protect the most heavily exposed surfaces, residual radiation levels of ~2 mr/hr at contact on the chamber parts can easily be attained for samples customarily encountered. Techniques for application of the strippable films and for decontamination of the chamber are discussed.

668 The Effect of Nuclear Motion on the Hyperfine Structure of Hydrogen. G. Breit, G. E. Brown, and G. B. Arfken. Phys. Rev. 76, 1299-1304(1949) Nov. 1. (See also NSA 2-323.)

The effect of nuclear motion on the hydrogen hyperfine structure is considered from the point of view of a Hamiltonian which is relativistic to order v^2/c^2. The discussion results in a clearer separation of the nonrelativistic correction factor 1-3m/M from relativistic effects than in previous treatments. The Hamiltonian applies through the interior as well as the exterior of the proton. By means of it the potential energy can be rounded off at small distances without contradiction to relativity, within the order v^2/c^2. A transformation involving a new effective charge allows the calculation of part of the effect without approximation and it becomes clear that higher order effects are not separable from the so far arbitrary assumptions concerning the proton's radius. Relativistic corrections to the fine structure are reconsidered by means of this transformation

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and the effect of the acceleration of the proton on the hyperfine structure is discussed. 13 references.

669 Effects of the Proton Radius on Nuclear Motion Correction for the Hyperfine Structure of Hydrogen. G. E. Brown and G. B. Arfken. Phys. Rev. 76, 1305-6(1949) Nov. 1.

Contributions to the hyperfine structure of the ground state of hydrogen resulting from the assumption of a nonvanishing proton radius are evaluated. These effects occur because of the assumed modification of the coulomb potential inside the proton and the consequent change in the wave function the above assumption implies. Since the proton radius and the shape of the potential function in the interior are not known, there occur uncertainties of relative order$(\alpha^2 m)/M$ in the hyperfine structure arising from nuclear mass motion.

670 Excitation of Light by Collisions of H- and He-Atoms with Atoms of Alkaline Metals. Karl Gailer. Z. Physik 126, 583-97(1949)(in German).

Neutral H- and He-atoms were made to collide with atoms of the alkali metals, and the excitation energy of the atoms taking part in the collisions was measured. For H-atoms with energies up to 20 kev, and for He-atoms up to 30 kev only an excitation of the alkaline atoms was observed (arc and spark spectra). As the atomic number of the alkaline atoms increased, the intensity of the spark spectra compared to that of the arc spectra increased. A comparison of the experimental results is made with the theory of Doepel (Ann. Phys. 16, 1(1933)) which predicts either excitation of the alkali arc spectrum without simultaneous excitation of the H- or He-spectrum, or an excitation of the alkaline arc and spark spectrum with simultaneous excitation of the H- or He-spectrum, and is thus at variance with the observed facts.

671 Hyperfine Splitting in Paramagnetic Resonance. D. J. E. Ingram. Proc. Roy. Soc. (London) 62A, 664-5(1949) Oct. 1 (Letter to the editor).

The hyperfine splitting of copper ions has been investigated using a method similar to that previously used for cobalt ions by Bleaney and Ingram (Nature 164, 116(1949)). A crystal of $ZnSO_4(NH_4)_2SO_4 \cdot 6H_2O$, in which about one zinc ion in every 1,000 was replaced by a copper ion, was investigated, using radiation of 3 cm wavelength and at a temperature of 20°K. The procedure was analogous to that used for a systematic survey of the copper Tutton salts (Bleaney et al, Proc. Roy. Soc. (London) A, (1949) in the press), except that the sensitivity of the apparatus was increased by modulating the applied d-c magnetic field, and the amplified output was fed directly to an oscillograph screen, the time-base of this being fed from the modulating coils. The results which were obtained are tabulated and the existence of an isotope splitting and a splitting due to a nuclear quadrupole moment are noted. Measurements have also been made on dilute cobalt and copper fluosilicates. The hyperfine structure of the cobalt ions behaves similarly to the Tutton salt, g varying from 5.4 to 3.4 and ΔH from 520 to 193 gauss, parallel and perpendicular to the trigonal

axis, respectively, but the copper ions now appear to have an isotropic g value.

672 Structure of the Line λ4686 of He II. K. Murakawa, S. Suwa, and T. Kamei. Phys. Rev. 76, 1721(1949) Dec. 1 (Letter to the editor).

In order to test the theory of level shift in hydrogen-like atoms, the fine structure of the line 4686 of He II was studied by means of a silvered Fabry-Perot etalon and a glass Lummer plate of thickness 4.7 mm. The transition scheme observed for the S terms was found to be in good agreement with that calculated theoretically (Bethe, Phys. Rev. 72, 33(1947); Dyson, Phys. Rev. 73, 617(1948); Kroll and Lamb, Phys. Rev. 75, 388(1949); French and Weisskopf, Phys. Rev. 75, 1240(1949)).

673 Theory of Doublet Spectra under Magnetic Perturbation. S. Sengupta. Indian J. Phys. 23, 287-300 (1949) July.

The problem of a spinning electron moving around the nucleus in the presence of an external magnetic field has been considered from the wave-statistical point of view. The general expressions for energies and wave functions for any field strength have been obtained. The problems of no field, weak field (Zeeman effect), and strong field (Paschen-Back effect) are considered as special cases. The results for the "no field" case are identical with those obtained in the earlier paper (Kar and Sengupta, Indian J. Phys. 23, 19(1949)). Other results also agree with the well known spectroscopic formulas.

674 2 Nitro 2, 4 Dimethyl Pentanone 3. M. R. Posten, B. I. V. Bailey, and W. H. Baldwin. AECD-2760, Nov. 1, 1949, Decl. Dec. 19, 1949. 3p.

Experimental details are given for the organic synthesis of 2 nitro-2,4 dimethyl pentanone-3 by reaction in the liquid phase of nitric acid with di-isopropyl ketone.

675 Biosynthesis of Penicillins. III. Preparation and Evaluation of Precursors for New Penicillins. Otto K. Behrens, Joseph Corse, Dorothea E. Huff, Reuben G. Jones, Quentin F. Spoer, and Calvert W. Whitehead. J. Biol. Chem. 175, 771-92(1948) Sept.

An investigation of the mode of action of certain compounds containing the phenylacetyl group and which stimulate penicillin production was made using deuterophenylacetyl-N^{15}-DL-valine. The preparation of this compound is described; benzylpenicillin was isolated following use of this as a precursor. Deuterium analyses demonstrated that the phenylacetyl portion of the precursor was incorporated directly into the penicillin; in contrast, very little N^{15} was found in the penicillin product. It is concluded, therefore, that the role of the amide portion is still unknown. 55 references.

676 Synthesis of Carbonyl-labeled Pyruvic Acid. H. S. Anker. J. Biol. Chem. 176, 1333-5(1948) Dec.

A description is presented of the synthesis of pyruvic acid labeled with C^{14} in the carbonyl group. It was synthesized

from isotopic carbon dioxide; and potassium acetate, acetyl bromide, acetyl cyanide, and pyruvamide were obtained as intermediates in the process. An overall yield of 40-70% was obtained; the product was stored in the form of pyruvamide, which is more stable than pyruvic acid.

677 A Synthesis of Isoguanine Labeled with Isotopic Nitrogen. Aaron Bendich, John F. Tinker, and George Bosworth Brown. J. Am. Chem. Soc. 70, 3109-13(1948) Sept.

Syntheses of 2-thioladenine, 2-carboxymethylthioladenine, 2,6-diaminopurine, adenine, and isoguanine are described. Isoguanine has been synthesized containing an excess of N^{15} in the 1 and 3 positions. A rigorous comparison of the synthetic product with natural isoguanine has been carried out through which it was seen that the synthetic product was more than 99.5% homogeneous, whereas the natural product contained about 5.5% of impurities.

678 Determination of Efficiency of Dealkalization of Glass Surfaces by Radioactive Sodium. J. V. Fitzgerald. Glass Ind. 30, 259-61(1949) May.

A simple technique using radioactive sodium is described which can be used to determine the efficiency of dealkalization as a function of time and temperature. Two different dealkalizing agents are compared. The technique used is essentially as follows: the Na^{23} in the glass is changed to Na^{24}, a radioactive isotope, by bombarding it with deuterons. The treated glass is then heated in contact with a dealkalizing agent which absorbs some of the radioactive sodium; after cooling, the agent is scraped from the glass surface and subjected to radioassay. Three graphs are included.

679 The Effect of Activator Concentration on the Infrared-Sensitive Phosphor, Strontium Selenide-Samarium, Europium. Hilda Texin, Harry Williams, and Roland Ward. J. Am. Chem. Soc. 71, 2494-8(1949) July.

Some improvements have been made in the procedure for making pure strontium selenide. It has been shown that the presence of strontium selenite and strontium silicate affect the luminescent properties of strontium selenide-europium, samarium phosphors. Small amounts of silicate cause an increase in the time lag of the phosphors under infrared stimulation. By using ammonium chloride to remove oxide which invariably is present in the phosphors, it has been possible to study the effect of activator concentrations upon the brightness of the strontium selenide-europium, samarium phosphor. The effect has been shown to be similar to that found in the strontium sulfide-europium, samarium phosphor.

680 Exchange Between Metals and their Ions in Solution. II. A Study on Mercury. M. Häissinsky and M. Cottin. J. chim. phys. 46, 476-9(1949)(in French).

In the study of exchanges between metals and their ions in solutions, surface processes modifying the surface and distorting the picture of the ion exchange proper can be avoided by the use of mercury (permitting stirring and spattering)

instead of solid metals. The authors used Hg^{203} (52 days) as a tracer in the reactions Hg + $Hg(NO_3)_2$, Hg + $Hg_2(NO_3)_2$ and Hg + $Hg_2(ClO_4)_2$. They found that the exchange between the metallic atom Hg and its ions is very rapid and varies little with the temperature and the nature of the anion. After all the surface atoms of Hg-droplets have exchanged, the process continues, by autodiffusion, in the interior of the metal phase; this latter process, being the slowest, (the ion diffusion in the solution is much faster), determines the global kinetic picture of the whole reaction. Therefore, it is the autodiffusion stage of the process that is primarily reflected in the activation heats measured by the authors. This interpretation is in agreement with the conclusions indirectly reached by the authors in a former study of the exchange between a solid metal and its ions (J. chim. phys. 45, 212 and 224(1948)).

681 Radioactive Isotopes of Carbon and Their Applications. B. V. Aĭvazov, M. B. Neĭman, and V. L. Tal'rose. Uspekhi Khim. 18, 402-48(1949)(in Russian).

This is a review of works on radioactive isotopes of carbon, giving 263 references, numerous tables, and diagrammatic views of instruments. Section I deals with the methods of obtaining and of determination of C^{14}, C^{11} and C^{10}, as well as with their physical characteristics. In section II the applications of these isotopes in chemistry, as tracers, are reviewed: synthesis of organic compounds (78 reactions mentioned), isotopic exchange, mechanism of oxidation, reaction of Orlov-Fischer-Tropsch ($CO + H_2 \rightarrow C_nH_{2n}$), and other reactions. Section III is devoted to the use of C tracers in biochemical studies: photosynthesis, assimilation of CO_2 by bacteria, assimilation of CO_2 by animal tissues, various reactions of metabolism.

682 Radioactive Tracer Study of Activator Distribution in Infrared Phosphor Systems: Effect of Strontium Oxide. J. Prener, R. W. Mason, and R. Ward. J. Am. Chem. Soc. 71, 1803-5(1949) May.

An improved method is described for determining the distribution of rare earth activator ions between the solid and liquid phases present in infrared-sensitive phosphor systems. The distribution constants, defined as the ratio of the mole fractions of the rare earth ion in the solid and liquid phases, have been determined for the rare earths samarium, cerium, and europium in the systems SrS-$SrCl_2$-SrO and SrSe-$SrCl_2$-SrO. The distribution constants of samarium and cerium decrease rapidly as the ratio of strontium oxide to strontium chloride increases. That of europium is relatively little affected by strontium oxide. These results explain qualitatively the observed brightness-composition variation in the phosphor SrS(Sm, Eu)$SrCl_2$, SrO.

683 Studies on Acid Hydrolysates of Vesicant-treated Insulin. Carl M. Stevens, John L. Wood, Julian R. Rachele, and Vincent du Vigneaud. J. Am. Chem. Soc. 70, 2554-6(1948) July.

Insulin which had been treated with a minute amount of n-butyl β-chloroethyl sulfide (butyl-H) containing radiosulfur was subjected to acid hydrolysis. By application of the "washing-out" technique, evidence was obtained for the presence of

radiosulfur-containing N-(β-butylmercapto)-ethyl-phenylalanine in the hydrolysate. Various control experiments provided no evidence for the attachment of vesicant residues to the amino group of phenylalanine during the hydrolysis procedure. Therefore, it was concluded that in the vesicant-treated insulin, a fraction of the vesicant had been attached to the free amino group of some of the phenylalanine moieties in the intact protein molecule.

684 A Study of the Exchange of Nickel in Certain Complex Compounds Using Radioactive Nickel. J. Enoch Johnson and Norris F. Hall. J. Am. Chem. Soc. 70, 2344-8(1948) July.

The nickel exchange of ten nickel coordination compounds was studied using Ni^{63} as the tracer. In the main the results, which are discussed in detail, show a satisfactory correlation with predictions of bond bype based on other criteria. Bis-methylbenzylglyoxime nickel, bis-methyl-n-butylglyoxime nickel, bis-N,N-di-n-propyldithiocarbamate nickel, bis-N,N-di-iso-amyldithiocarbamate nickel and bis-salicylaldehyde-ethylenediamine nickel was found not to exchange under the experimental conditions used in accordance with expectation based on the magnetic and other structural evidence for strong covalent bonds. The two dithiocarbamate compounds of nickel did, however, show exchange with nickel perchlorate in the presence of ammonia. Bis-salicylaldehyde nickel and tris-ethylenediamine nickel chloride were found to exchange as predicted. Bis-salicylaldoxime nickel and bis-salicylaldimine nickel, although diamagnetic in the solid state, were found to exchange. This is believed to be evidence that these compounds exhibit a change of bond type when dissolved in methyl cellosolve. Although tris-α,α'-dipyridyl nickel chloride heptahydrate has been resolved into its optical isomers and was not, therefore, expected to exchange, it did exchange at a measurable rate. This may be connected with the racemization observed for this compound.

685 The Use of Carbon-14 in the Determination of the Structures of Aldoketene Dimers. John D. Roberts, Rose Armstrong, R. F. Trimble, Jr., and Marion Burg. J. Am. Chem. Soc. 71, 843-7(1949) Mar.

The isotopic tracer technique has been used to demonstrate that the mixed aldoketene dimer of methyl- and hexylketenes prepared by the Wedekind reaction (Ber. deut. chem. Ges. 34, 2070(1901)) does not have a cyclobutanedione 1,3 structure. The studies were based on the examination of degradation products of the radioactive compound. The physical properties of several aldoketene dimers indicate that these substances probably have structures similar to diketene and are best formulated as vinylaceto-β-lactone or β-crotonolactone derivatives.

686 Application of Neutron Diffraction on the Study of the Structure of Crystalline Substances. R. P. Ozerov. Uspekhi Fiz. Nauk 38, 413-27(1949)(in Russian).

An account on the use of neutron diffraction in crystallographical studies is presented, with a list of references (years 1947 and 1948), all American. The instruments are

described, the theory of neutron scattering is outlined, and the interpretation of the neutronograms explained on several examples of crystalline structure. The influence of the presence of isotopes and of the nuclear spin on the effects observed is pointed out.

687 Bibliography of Research on Heavy Hydrogen Compounds. Compiled by Alice H. Kimball, Harold C. Urey and Isidor Kirshenbaum, Eds. New York, McGraw-Hill, 1949. 350p. NNES Div. III, Vol. 4C.

This work consists of approximately 2,000 references to published literature on deuterium and deuterium compounds. The majority (80%) of the references were obtained from Chemical Abstracts for the period January 1932 to December 1945, and in most such cases the Chemical Abstracts reference is given. Most of the other material was obtained directly from the literature published during the years 1932-1936. The bibliography consists of three parts corresponding to indexing according to author, subject, and compound.

688 The Kinetics of the Oxidation of 2-Deuteropropanol-2 by Chromic Acid. F. H. Westheimer and Nicholas Nicolaides. J. Am. Chem. Soc. 71, 25-8(1949) Jan.

When Adams catalyst, activated by ferrous chloride, is used, the deuteration of acetone is accompanied by some hydrogen-deuterium exchange. The product here obtained was a mixture containing 55% of 2-deuteropropanol-2. The rate of chromic acid oxidation of this product was only 52% of that of ordinary isopropyl alcohol. On the basis of this result, it is calculated that the rate of chromic acid oxidation of pure 2-deuteropropanol-2 should be about one-sixth that of pure isopropyl alcohol. The lower rate of oxidation of the 2-deutero compound (which arises from differences between the zero point energies of the C-H and C-D bonds) proves that the secondary hydrogen (or deuterium) in isopropyl alcohol is removed in the rate controlling step of the chromic acid oxidation.

689 Studies of Fluorides. Gilson Henry Rohrback. University of Washington, 1949. 85p. (NP-1025).

The investigation has been undertaken in four separate phases as follows: (1) The preparation of new compounds analogous to NO_2F, wherein the hydrogen of an acid is replaced by a fluorine atom. The reaction products of the salts of the acids with fluorine gas were examined as well as those of the acids themselves. Of the several substances investigated only $HClO_4$ was found to yield a new compound, ClO_4F. (2) Determination of the surface tensions and refractive indexes of the perfluoropentanes. (3) Mathematical application of the existing theories of intermolecular attraction in order to calculate binding energies between molecules of fluorocarbons in the liquid state. (4) Study of the liquid-vapor equilibrium for the binary system tungsten hexafluoride-perfluorocyclopentane as a means of further evaluation of the present theories of solubility. 42 references.

690 Fractionation of Lanthanum and Neodymium Nitrates by Solvent Extraction. Charles C. Templeton and John A. Peterson. J. Am. Chem. Soc. 70, 3967-8 (1948) Nov. (Letter to the editor).

The authors carried out batch extractions of aqueous solutions of lanthanum and neodymium nitrate mixtures with n-hexylalcohol at room temperature. A spectrophotometric method was used to determine neodymium, and the total oxides were determined by ignition. All percentages of oxides were expressed relative to the total oxides in a nitrate sample. Aqueous phases were kept about 90% saturated in the total nitrates. Two single extractions showed:

	I	II
Nd_2O_3, aqueous, %	53.7	46.1
Nd_2O_3, alcohol, %	63.2	57.0
Separation factor	1.48	1.55

691 The Principal Magnetic Susceptibilities of Single Crystals of Rare Earth Salts at Low Temperatures. Part II. Praseodymium Salts. A. Mookherji. Indian J. Phys. 23, 309-20(1949) July. (See also NSA 4-132.)

The principal susceptibilities of praseodymium salts have been measured at temperatures ranging from room temperature down to liquid air temperature. The results are discussed in terms of the crystalline electric field theory. It is found that: (1) on the basis of a single suitable cubic field the observed magnetic moment at all temperatures in the range studied can be explained satisfactorily; (2) the observed large anisotropies of the crystals point to the existence of a strongly asymmetric rhombic field; (3) a rough estimate of the rhombic part of the field shows that the splitting produced is appreciable and of the order of the cubic splitting; and the X_1-axis of praseodymium sulphate rotates by about 63° in the range studied.

692 Applications of the Intermittent a-c Arc. Part II. Determination of Rare Earths. J. A. C. McClelland. Analyst 74, 592-35(1949) Oct.

A method is described for the spectrographic determination of small amounts of rare earth elements present in minerals, to include all known members of the rare earth group proper, that is, the lanthanides, and other elements usually associated with the group, namely, yttrium, scandium, and thorium. The rare earth elements are first separated from the major mineral constituents by chemical means, and ignited to oxide after addition of an iron salt to serve as an internal standard. Standards are prepared from pure rare earth oxides mixed with iron oxide. The concentrates and standards are ground with potassium hydrogen sulphate, and fused onto cupped graphite rods, pairs of which are used as electrodes in the intermittent a-c arc discharge. 4 tables.

693 Artificially Produced New Elements. Otto Hahn. Berlin, Verlag Chemie, 1948. 50p. (in German).

The main part of the book consists of a compilation concerning artificially produced new elements, for which no stable isotopes are known. Attention is given to transuranic elements with atomic numbers from 93 to 96. Technical means of their production are discussed.

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694 The Crystal Structure of UBi. Leo Brewer, Russell K. Edwards, and David H. Templeton. AECU-653 (UCRL-433), Nov. 15, 1949. 16p.

This report is a revision of AECD-2730, which is listed in Nuclear Science Abstracts as Abstract 4-137.

ENGINEERING

695 Isotopes as Tools of Engineering. Paul C. Aebersold. Mech. Eng. 71, 987-990, 1031(1949) Dec.

A short discussion is given on how radioactive isotopes are used and why they are important. Many applications of radioisotopes are presented. Some of these are listed below: simple tracer analysis, isotope-dilution analysis, self diffusion measurements in iron and cobalt, studying friction and wear, and applications in gauges.

MINERALOGY, METALLURGY AND CERAMICS

696 Thermionic Emitting Properties of Two Refractories. R. E. Haddad, D. L. Goldwater, and F. H. Morgan. J. Applied Phys. 20, 1130(1949) Nov. (Letter to the editor).

The authors have investigated the thermionic emitting properties of two more refractory carbides (J. Applied Phys. 20, 886(1949)). These are tantalum carbide and titanium carbide. Both were applied as coatings on tungsten wire, and tested in guard-ringed diodes. Values of A and b are obtained for the Richardson equation $I_S = AT^2e^{-b/T}$, ($b = 11{,}605\phi$). The values obtained are: for tantalum carbide, A = 2. (1) amp/degree K^2 cm^2, ϕ = 3.0(5)v. For titanium carbide, A = 2. (5) amp/degree K^2cm^2, ϕ = 3.3(5)v. The emission available does not seem to be of practical interest for either of these materials. At 1727^oC_b, maximum space-charge limited emission from titanium carbide is about 0.4 amp/cm^2. At 1672^oC_b, maximum space-charge limited emission from tantalum carbide is about 0.2 amp/cm^2. The spectral emissivities of both materials were obtained, as necessary to the experiment. For titanium carbide, this emissivity, as measured at 0.655μ, is 0.96 $\pm$ 0.04. Brightness temperatures for this material may hence be regarded as true centigrade temperatures. For tantalum carbide, the emissivity determined is 0.75 $\pm$ 0.03.

697 Metallurgical Laboratory at Oak Ridge. L. K. Jetter and E. E. Stansbury. Metal Prog. 56, No. 9, 187-93 (1949) Aug.

Metallurgical studies of the heavy elements, the transuranium metals, and materials for reactors and powder piles, require unusual precautions against contamination of personnel, equipment, and building structure by radioactive or toxic fumes or particles, even when the level of activity is far too low to confine the materials to a "hot" laboratory. This description of the newly completed metallurgical laboratory at Oak Ridge National Laboratory gives a good idea of how these conditions are met.

698 The Physical Properties of Titanium. I. Emissivity and Resistivity of the Commercial Metal. Walter C. Michels and Sally Wilford. J. Applied Phys. 20, 1223-6(1949) Dec.

The resistivity and the total emissivity of commercial titanium have been measured over the temperature range from room temperature to 1400°K. The resistivity at 20°C is 78.6 microhm cm. Above this temperature it increases to a flat maximum of 182 microhm cm at the temperature of the hexagonal-body-centered cubic transformation. The total emissivity is about 0.31 at low temperatures and there is some indication that it shows a maximum near the transition temperature. The spectral emissivity and the brightness temperature scale are also determined over the range of 1000-1400°K.

699 The Preparation of Beryllium Foil. H. Smith. J. Sci. Instruments 26, 378-9(1949) Nov. (Laboratory and shop note).

The preparation of beryllium in a form suitable for the windows of x-ray tubes has been adequately discussed by Brackney and Atlee (Rev. Sci. Instruments 14, 59(1943)). Several methods of preparation, previously used by other workers, are described. In general these methods involve the evaporation of beryllium onto some kind of smooth surface. The metal is supported by some refractory material which is heated by electron bombardment. However, difficulties have been encountered in the past because of poor thermal contact between the metal and the supporting material. These difficulties may be overcome by using a perforated disk of Acheson graphite for support. Some of the electrons will go through the holes and hit the beryllium directly, improving the efficiency of the heating process. Several foils were prepared by this method with good results.

700 Preparation of Zirconium by Fused Salt Electrolysis. W. C. Lilliendahl and D. Wroughton. NYOO-1010, Sept. 15, 1949. 12p.

An investigation has been made of the possibility of obtaining zirconium metal by electrolytic deposition from a fused salt electrolyte. The primary objective of the work was to establish the essential feasibility of producing coherent zirconium directly by such a process, but the project was curtailed abruptly and only preliminary investigations have been completed. Specific electrolytes investigated comprised two-component eutectic mixtures of NaCl, KCl, $CaCl_2$, and KF, respectively, to which $ZrCl_4$ was added. The results indicate that a satisfactory electrolysis is possible with the three eutectics KCl—NaCl, $CACl_2$—KCl, and KF—KCl, the product being zirconium powder in all cases with the particular conditions of operation. The results further show that $ZrCl_4$ forms a stable solution in fused salt baths containing a potassium salt at temperature of about 750°C. The yields of zirconium powder and current efficiencies for the eutectic baths KCl—NaCl and $CaCl_2$—KCl have been estimated and the approximate metal content of the deposited powder determined. Microscopic investigation of the powder obtained suggests the possibility of plating from some compositions, particularly the KF—KCl eutectic.

MINEROLOGY, METALLURGY AND CERAMICS

701 Survey of Theories of Creep of Metals. M. W. Nathans, E. R. Parker, and T. H. Hazlett. COO-2, Nov. 15, 1949. 63p.

The following subject matter is discussed in the present paper: (1) the Becker-Orowan Theory; (2) the theory of dislocations, including the work by Mott, Frank, and Nabarro in Bristol; (3) additional theories and hypotheses, such as the Smekal theory, the recovery theory, and the theories of Bragg and Cottrell; (4) intragranular slip mechanisms and the question of more than one mechanism. An attempt is made to judge the different theories as to their relative merits, and the requirements for future developments are outlined. 91 references.

702 Titanium—Its Occurrence, Chemistry, and Technology. Jelks Barksdale. New York, The Ronald Press Co. nd. 591p.

The book is divided into 28 chapters, each one of which is profusely documented. The author delves into such topics as the occurrence, geology, and mineral deposits which yield titanium; production and import of ores and the chemistry of elemental titanium. The 20-odd chapters which deal with processes, applications, and uses are well collated. They include intimate details on pigment manufacture and sketchier information on alloys, ceramics, catalysts, mordants, and dyes.

703 Radium Content of Ultramafic Igneous Rocks. II. Geological and Chemical Implications. G. L. Davis and H. H. Hess. Am. J. Sci. 247, 856-82(1949) Dec.

Results of recently published measurements of the radium content of some ultramafic igneous rocks and of the constituent minerals are used to demonstrate the relationship of decreasing radium (and uranium) content with increasing mafic character of rocks. The probable redistribution of uranium during partial fusion, crystallization, and alteration is considered. It is shown that in ultramafic rocks the radium is probably present in impurities that represent less than 1% of the rock and are the consolidation products of the residual solution. The causes of contamination are discussed.

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704 Isotopes in Stellar Atmospheres. Andrew McKellar. Pubs. Astron. Soc. Pacific 61, 199-209(1949) Oct.

The general problem of detecting the presence of isotopes in stellar atmospheres is discussed. The relatively few cases for which information can be obtained are noted and the present situation for each is briefly reviewed. The case of the carbon isotopes C^{12} and C^{13} in the R- and N-type stars, for which the most interesting and extensive data are available, is treated in some detail.

705 On the Physical and Chemical Composition of the Sun. Geoffrey Keller. Astrophys. J. 108, 347-53 (1948) Nov.

A radiative-envelope-convective-core model of the sun has been constructed on the assumption that the radiative opacity is due to oxygen. It is found that the abundances of hydrogen, helium, and heavy elements for the new model differ markedly from those obtained by M. Schwarzschild (Astrophys. J. 104, 203(1946)) on the assumption that the opacity is due to a Russell mixture. In order to obtain an independent criterion for deciding which model is more nearly valid, the apsidal motion properties of the models have been investigated. A comparison of the apsidal motion computed for the models with the observed apsidal motion of main-sequence binary stars indicates that the sun most nearly conforms to an intermediate model. It is found that for the intermediate model the ratio by weight of the oxygen group of elements to all the heavy elements is 0.85. The hydrogen, helium, and heavy-element abundances are 0.67, 0.29, and 0.045, respectively. These results are in good agreement with spectroscopic analyses of stellar atmospheres.

706 Review of Observations of Meson Production and Behavior at the University of California Radiation Laboratory. Walter H. Barkas. AECU-590(UCRL-427), Aug. 23, 1949. 14p.

Meson production has been observed using high energy beams of protons, α particles, photons, and neutrons. The observations are consistent with the supposition that π mesons of both signs are produced in the primary process. The threshold for production of mesons is somewhat above the mass energy of the meson as expected. For α particles some production has been observed as low as 266 Mev and the excitation function has been measured up to 380 Mev. The differential cross sections for production in carbon by 380-Mev alphas of negative mesons is 3.8×10^{-30} cm²/carbon nucleus/Mev/steradian. This applies to mesons of energy in the vicinity of 4 Mev observed in the forward direction. For protons some production has been observed as low as 204 Mev, and the excitation function has been measured up to 340 Mev. The differential cross section for production of negative mesons by 340-Mev protons in carbon is 1.0×10^{-30} cm²/carbon nucleus/1 Mev/steradian. This applies to mesons in the vicinity of 12 Mev observed in the forward direction. The positive to negative production ratio of mesons by α particles is found to fall rapidly with atomic number in the low energy region of the meson spectrum. Protons produce many more high energy positive mesons in carbon than negative mesons of similar energy, while photons produce an excess of negative mesons. The cross section for meson production by 335-Mev photons is 1.2×10^{-29} cm²/nucleon for mesons in the ranges 35-150 Mev. Neutrons of about 300 Mev produce stars in nuclear emulsions. From about 1 in 1300 of these stars, low energy mesons are observed. Half-lives of positive and negative π mesons have been measured. In each case the half-life is in the vicinity of 10^{-8} sec. High energy photons, which may be the decay products of neutral mesons, are observed to be produced at the cyclotron target under high energy proton bombardment. The negative π mesons which stop in the emulsion cause nuclear disintegrations yielding charged particles in 73.2% of the cases. Negative μ mesons arise from the decay in flight of negative pi mesons, and seldom, if ever, produce charged particle nuclear disintegrations in the emulsion. The positive π mesons usually are observed to decay into a positive μ meson. The μ mesons are observed to have a range of 594 ± 6 μ in Ilford emulsion. The stopping

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power of nuclear emulsions is found to be seriously affected by humidity. With dry Ilford emulsions the range-energy relation found for protons is: $E = 0.25\ R^{0.58}$ where E is the energy in Mev and R is the range in μ. This relation has been obtained for protons of energies 17-39 Mev.

707 The Excess of Negative over Positive Mesons Produced by High Energy Photons. K. A. Brueckner and M. L. Goldberger. AECU-657(UCRL-468). Oct. 3, 1949. 4p.

The ratio of negative to positive mesons produced by the high energy photon beam from the UCRL 330-Mev synchroton has been found to be 1.7 ± 0.2 with no significant energy dependence. Observations were made with a carbon target for mesons in the energy range 30-130 Mev at 90 deg. to the photon beam. The effects of the coulomb field of the nucleus on the production of mesons have also been investigated and found to be less than 5% for mesons with energies above 30 Mev. The calculated ratio of the cross sections for the production of negative and positive mesons varies from 1.55 at 40 Mev to 1.83 at 100 Mev, at 90 deg. to the proton beam. This agrees, within the probable error, with the experimentally observed ratio.

708 Erratum: Altitude Dependence of Penetrating Particles Slowed Down After Traversing 15 cm of Lead. Marcello Conversi. Phys. Rev. 76, 1541(1949) Nov. 15 (Letter to the editor).

Two numerical errors are noted in a previous article by Conversi (Phys. Rev. 76, 851(1949)). See NSA 3-1683 for abstract of article.

709 An Analysis of Bursts of Cosmic-Ray Ionization. C. G. Montgomery and D. D. Montgomery. Phys. Rev. 76, 1482-8(1949) Nov. 15. (See also NSA 2-1900.)

The agents responsible for the production of bursts of ionization in small chambers have been analyzed on the basis of observations taken at 3,510 m elevation. Three methods of separation were employed: (1) the coincidences between ion chambers and between chambers and counters, (2) the variation of burst rate with a small thickness of lead placed over the chamber, and (3) the variation of burst rate with the size of the ionization chamber. Three components of the burst distribution curve are identified with (1) small locally produced electron showers, (2) nuclear disintegrations, and (3) extensive air showers of high density. Each component predominates at a certain range of burst sizes.

710 Calculation of Moments of the Distribution Function of Cascade Particles. S. Z. Belen'kiĭ. Zhur. Eksptl. i Teoret. Fiz. 19, 940-5(1949)(in Russian).

A recursion formula is derived, with the aid of which the determination can be made, successively, of all the moments of the distribution function of cascade particles. By using the method of moments, the distribution function is calculated for certain limiting cases.

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711 Comparison of Calculations on Cascade Theory. Hartland S. Snyder. Phys. Rev. 76, 1563-71(1949) Dec. 1. (See also NSA 2-1797.)

The diffusion equations of the cascade theory of electron showers are solved using improved mathematical methods. The results obtained agree essentially with those obtained earlier by Carlson and Oppenheimer, by Snyder, and by Serber (Phys. Rev. 51, 220(1937); 53, 960(1938); 54, 317(1938)), but do not agree with those obtained by Bhabha and Chakrabarty (Phys. Rev. 74, 1352(1948)). Solutions are given corresponding to a single incident electron, a single incident γ ray, and a 1/E spectrum of γ rays. The total number of particles expected under a given thickness of material are given in tables for various incident energies and each of the above initial conditions. Other tables and formulas are included which enable one to calculate the spectrum of the particles and γ rays for various initial conditions.

712 Cosmic Rays in the Atmosphere. Satio Hayakawa and Jun Nishimura. J. Sci. Research Inst. 44, 47-58 (1949) Nov.

A phenomenological description is given of the behavior of cosmic rays, in particular, of protons and mesons, in the atmosphere. The authors conclude from the experimental evidence that the primary integral spectrum $P_0(\epsilon)$ and differential spectrum $p_0(\epsilon)$ should lie between $P_0(\epsilon) = (4.45/\epsilon^{1.8}) - (7.0/\epsilon^{2.5})$, $p_0(\epsilon)\,d\epsilon = \{(8/\epsilon^{2.8}) - (17.6/\epsilon^{3.5})\}\,d\epsilon$; and $P_0(\epsilon) = (8.8/\epsilon^{2.0}) - (21/\epsilon^{2.8})$, $p_0(\epsilon)d\epsilon = \{(17.6/\epsilon^{3.0}) - (59/\epsilon^{3.8})\}\,d\epsilon$ where ϵ is the energy in Bev. Then the altitude variation of proton intensity due to collisions with air nuclei is calculated on the assumption that a constant fraction v_0 of the energy is lost in each collision. From the experimental absorption mean free path of nucleons (125 g cm^{-2}) it is deduced that for the primary spectrum assumed v_0 ranges from 0.31 to 0.34. The (multiple) production of charged π mesons with total energy between E_0 and $E_0 + dE_0$ by nucleons with kinetic energy ϵ is assumed to have the probability $\psi(\epsilon, E_0)\,dE_0 = C\,\epsilon^{\alpha} E_0^{\beta-1}\,dE_0$ from which an energy spectrum of the π meson is deduced. Diffusion equations are then set up and solved which describe the spectrum of the π mesons as well as that of the μ mesons resulting from their decay as a function of altitude. A comparison between theory and experiment is made for the intensity of the hard component in the upper atmosphere, the energy spectrum of mesons at sea level, and the latitude effect at sea level and at high altitudes. Agreement is found satisfactory as various parameters left open in the theory are suitably adjusted.

713 The Decay of μ-Mesons. J. H. Davies, W. O. Lock, and H. Muirhead. Phil. Mag. 40, 1250-60(1949) Dec.

The energy of the charged particles from the decay of μ-mesons in photographic emulsions has been determined, using multiple scattering techniques. The results indicate that the energy distribution is continuous with a peak in the 35-40-Mev region. The average energy is 40 Mev. It is concluded that a μ-meson decays to an electron and two neutrinos. These results are in reasonable agreement with those of other workers.

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714 Disintegration Electrons From Li_3^8 Nuclei Ejected in Cosmic Stars. E. Pickup and L. Voyvodic. Phys. Rev. 76, 1534-5(1949) Nov. 15 (Letter to the editor).

In a sensitive batch of Ilford G5 emulsions, four cosmic ray stars have been observed which show hammer tracks and in which the Li^8 disintegration electrons can be clearly seen. A photomicrograph of one such event is reproduced. Grain counts were taken on these electron tracks as well as on the meson tracks in the associated stars. It was found that some of the lighter tracks would not have been observed in less sensitive plates and this might lead to misinterpretation of stars observed in such plates.

715 The Disintegration of Varitrons. A. O. Vaisenberg. Zhur. Eksptl. i Teoret. Fiz. 19, 727-30(1949)(in Russian).

With the aid of an electronic circuit, comprising a delay line that permitted the determination of the time of disintegration of varitrons in the interval from 1.3 to 7.8 sec, the mass spectrum of varitrons was obtained at 3250 m altitude. It was found that in this interval of time, not only varitrons with the mass 220 m_e (where m_e is the mass of the electron), but also varitrons of greater and smaller masses undergo disintegrations in lead filters. Altogether 38 coincidences were recorded in 500 hr, of which number about 10% should be attributed to the background formed by stray coincidences (among them all those produced by negative particles); the remaining 90% are disintegrations of positive varitrons of various masses.

716 Evidence for Multiple Meson and γ-Ray Production in Cosmic-Ray Stars. M. F. Kaplon, B. Peters, and H. L. Bradt. Phys. Rev. 76, 1735-6(1949) Dec. 1 (Letter to the editor).

On a Kodak NTB3 plate flown at 100,000 ft a collision of an α particle (with an estimated energy of 0.8×10^{13} ev) with a heavy (Ag or Br) nucleus was recorded. The collision produced a very narrow penetrating shower core of 23 relativistic particles, this core being surrounded by a more diffuse shower of 33 relativistic particles. In addition 18 nonrelativistic particles, carrying at least 23 units of charge and a total energy of 3 Bev emerge from the star. In the region where the narrow shower core after passage through 2 cm of glass penetrates the next plate of the stack, 44 tracks of relativistic particles were found, that is more than were present in the original shower core. The authors conclude that considerable charge multiplication has occurred in the core, which is also confirmed by the fact that 8 to 10 electron pairs are created in the core over an average path length of 0.26 radiation units of glass and emulsion. Thus the event described gives evidence for the multiple production of γ rays. If the γ rays result from the decay of neutral mesons of mass 150, the upper limit of the lifetime of these mesons can be estimated to be $\lesssim 10^{-13}$ sec.

717 Investigation of the Mass Spectrum of Varitrons. I. A. Alikhanyan, V. Morozov, A. Khrimyan, G. Muskhelishvili, and V. Kamalyan. Zhur. Eksptl. i Teoret. Fiz. 19, 1021-56(1949)(in Russian). (See also NSA 2-98, 2-1202, 2-1203, 3-1700.)

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Using magnetic analysis, the mass spectrum of varitrons in cosmic radiation was investigated. Owing to a greater resolving power of the instrument, the varitron masses obtained are more accurate than those found in the authors' previous works (Doklady Akad. Nauk S.S.S.R. 58, 1321(1947); Zhur. Eksptl. i Teoret. Fiz. 18, 673 (1948)). The use of low-efficiency counters that recorded only a small percentage of relativistic particles permitted the determination of the ionizing power of varitrons absorbed in lead. The fact that the absorption in the filter is due to ionization losses proves the applicability of the method employed for the measuring of a particle's mass, viz., from its range and its momentum. The spectrum of momenta of the unfiltered radiation in the air shows significant irregularities, in the shape of narrow maxima and plateaus, corresponding to varitrons of different masses. The narrowness of the maxima indicates the short half-lifetime of some of the varitrons, which is much shorter than 10^{-6} sec. The spectra show important positive excesses: at 3,250 m altitude about 13% of all particles are fast protons; furthermore, there exists in air a great excess of positive varitrons heavier than the proton.

718 Narrow Air Showers of Cosmic Rays. John Wei and C. G. Montgomery. Phys. Rev. 76, 1488-93(1949) Nov. 15.

Observations are reported of the decoherence curves for air showers of cosmic rays at sea level, 1,640 m, and 3,510 m elevation. The variation of the decoherence curves with counter area and the absorption of narrow showers were also measured at the highest elevation. It was found that narrow showers (that is, showers observed at small counter separations) differ from ordinary extensive air showers with respect to variation with elevation, variation with area of the counters, and penetrating power. Consideration of the effects of pressure on the spreading function show that the altitude variation cannot be taken as a certain indication that narrow showers differ in nature from extensive ones, nor can the variation with counter area. The relative penetration, however, of narrow showers in lead, iron, and aluminum cannot be explained except by differences in the nature of the particles involved.

719 Narrow Atmospheric Showers of Particles in Cosmic Rays. M. V. Nezlin, I. L. Rosental, and S. A. Slavatinskiĭ. Doklady Akad. Nauk S.S.S.R. 65, 641-4(1949)(in Russian).

The presence of electrons and photons in narrow showers has been observed in a previous work (Kuchaĭ and Rosental, Doklady Akad. Nauk S.S.S.R. 60, 1523(1948)). However, since the conclusions were based mainly on a series of two-particle coincidences, several objections as to the adequacy of the method present themselves. Besides narrow showers, the effect observed could be produced by correlated pairs; on the basis of Berestetskiĭ's calculations (J. Physics U.S.S.R. 9, 197(1945)), Alikhanian et al (J. Physics U.S.S.R. 9, 175 (1945)) have estimated that the possible role of pairs was vanishingly small; however, Berestetskiĭ had assumed an

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equilibrium spectrum of the soft component, an assumption that the recent observations at 3,000-4,000 m altitude do not justify (Bernardini et al, Phys. Rev. 73, 328(1948); Azimov, Doklady Akad. Nauk S.S.S.R. 61, 1005(1948)). These considerations motivated a new investigation, (at 3,860 m altitude), using three-particle coincidences in three counters separated by lead partitions 7 cm thick. The dependence of the number of coincidences on the thickness of a Pb filter placed above the counters is shown in a curve exhibiting a well marked maximum at 1-2 cm Pb. This can be due, besides the electron-photon component of narrow showers, to either small-density extensive showers or "special" showers generated in Pb (Zhdanov et al, Doklady Akad. Nauk S.S.S.R. 55, 119(1947)). By using several modifications of the experiment, which also revealed the presence of penetrating particles, it was concluded that the observed electron-photonic effect was due to narrow showers.

720 Neutron Production at Mountain Altitudes. C. G. Montgomery and A. R. Tobey. Phys. Rev. 76, 1478-81(1949) Nov. 15.

The rate of production of neutrons by cosmic rays was measured at 3,510 m elevation in lead, aluminum, and paraffin, and in paraffin at 1,640 m elevation by means of an ionization chamber filled with boron trifluoride. The variation with elevation for production in paraffin differs slightly from that in the heavier elements, but agrees well with observations by other observers of the production in air at higher altitudes and with the variation of extensive showers. The neutrons are produced with a larger multiplicity in lead than in paraffin. Comparison with measurements of star production in photographic plates results in the value of three to six neutrons per star. Bursts of ionization resulting from other cosmic-ray phenomena were also observed.

721 On the Existence of Light Varitrons. A. I. Alikhanyan, A. A. Konstantinov, V. M. Kharitonov, and M. I. Daĭon. Zhur. Eksptl. i Teoret. Fiz. 19, 857-67(1949)(in Russian).

By the method of magnetic separation, spectra of momenta of cosmic rays, in the energy range from 30 to 80 Mev, were investigated, with the result that particles with masses 150, 100, 80 and (perhaps) 50 m_e must be present in the radiation studied (m_e is the mass of the electron). Furthermore, particles of a higher penetrating power, (traversing 2.5 cm Al), were recorded, and interpreted as electrons generated in air as a result of a decay of varitrons 184, 224, and 290 m_e. Recently, several authors have observed meson-decay electrons of widely diverging energies (Leighton et al, Phys. Rev. 75, 1432(1949); Hinks et al, Phys. Rev. 74, 697(1948); Kan-Chang Wang et al, Phys. Rev. 74, 1547(1949)); they explained this fact by a disintegration of the meson into three particles. However, the present authors prefer not to depart from the simpler mechanism of a two-particle disintegration, by recurring to varitrons having various masses.

722 On the Shape of the "Correlation Curve" of Auger Showers for Large Distances. D. V. Skobel'tsyn.

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Doklady Akad. Nauk S.S.S.R. 67, 255-8(1949)(in Russian).

In a previous paper (Doklady Akad. Nauk S.S.S.R. 67, 45 (1949)) the author has applied the cascade theory to a set of observations on atmospheric showers, which were made by Zatsepin et al (Zhur. Eksptl. i Teoret. Fiz. 17, 939(1947)) with the aid of widely separated counters (1,000 m); he found that the calculated effect is much weaker than that observed. However, being based on certain points in the cascade theory that lack in definiteness (e.g., in the estimation of the shower's radius R), the calculation may be considered as not sufficiently convincing. In the present note, the arbitrariness is avoided by comparing, not the absolute values of C(D) (where C is the number of coincidences, and D is the distance between counters), but the shapes of the "correlation" curve C(D) for $D \gg R$; it can be shown that there exists a simple correspondence between this curve and the density distribution of the shower at large distances from the latter's axis. By following this method, the results of the previous paper are confirmed: the cascade theory does not account for the effect observed. Its true cause may be looked for in the explosive nuclear processes generating "special" showers of mixed composition (Alekseeva et al, Doklady Akad. Nauk S.S.S.R. 63, 375(1948)). Or else, one may visualize an early separation of "genetically related" atmospheric showers with essentially parallel axes, so that two showers, and not a single gigantic one, are recorded by widely separated counters (Skobel'tsyn et al, Phys. Rev. 71, 315(1947)).

723 On the Widest Atmospheric Showers of Cosmic Radiation. D. V. Skobel'tsyn. Doklady Akad. Nauk S.S.S.R. 67, 45-8(1949)(in Russian).

While working on atmospheric showers at 3,860 m altitude, Zatsepin and Miller (Zhur. Eksptl. i Teoret. Fiz. 17, 939 (1947)) have observed coincidences in counters 1,000 m distant from each other. The present author (Phys. Rev. 71, 315 (1947)) thought that some special aspects of the phenomenon, unknown to the usual cascade theory, were here involved. On the other hand, in Cocconi's opinion (Phys. Rev. 72, 350(1947)), the showers observed were ordinary Auger showers produced by primaries of 10^{17}-10^{18} ev, whose intensity must be larger than that obtained by extrapolating Millikan's spectrum. However, both Cocconi's and the author's calculations were based on erroneous assumptions. A revised calculation is presented here, based, as before, on the application of Moliere's curve (Kosmische Strahlung. Berlin, 1943. p. 24) but including the more recent data from the computations of Belen'kiĭ (Cascade Processes in Cosmic Rays. Russia, 1948. p. 198 (in Russian)). The calculated number of coincidences in groups of counters distant 1,000 m is found to be many (30 and more) times larger than that counted by Zatsepin and Miller. The cascade theory, in its present state, cannot account for the observed wide extension of the limits of atmospheric showers; (the accepted limit was 300 m, corresponding to the limiting, and unreliable, point in Auger's curve).

724 Remarks on Multiple Meson and Gamma-Ray Production. R. E. Marshak. Phys. Rev. 76, 1736(1949) Dec. 1 (Letter to the editor).

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An analysis of the Berkeley experiments on meson production (Bjorkland et al, Phys. Rev. (to be published)) and of cosmic ray stars, especially the star recently reported by Kaplon et al (Phys. Rev. 76, 1735(1949)) leads to the following picture: the high energy γ rays originate in both experiments from the rapid decay of a neutral meson with a mass of ~300 electron masses, most likely neutral and with spin zero, and a lifetime of $\sim 10^{-13}$ sec. It is furthermore pointed out that once the neutral meson hypothesis is accepted, the electron pairs arising from the γ rays supply an approximate measuring scale for the meson energies, which, together with the angular distribution of the charged mesons, makes it possible to test various theories about the primary collision between the nucleons, in which the mesons are produced.

725 The Structure of Cosmic Ray Air Showers. J. R. Prescott and C. B. O. Mohr. Australian J. Sci. Research 2 A, 184-97(1949) June. (See also NSA 3-978.)

The structure of cosmic ray air showers at sea-level has been studied by an investigation of the burst rate frequency and the transition effect in lead, for cosmic ray bursts occurring simultaneously in two high-pressure ionization chambers with varying separation. Although extensive showers were responsible for all the coincidences observed with the larger chamber separations, they accounted for less than 3% of the bursts observed with a single chamber. Of the remaining 97%, somewhat more than one-half appear to be due to nuclear disintegrations and the rest either to narrow showers of approximate radius 30 cm or to the core of an extensive shower of low density. The extensive shower frequency was about 10 times that predicted by theory. The bearing of these results on present views of the origin and development of air showers is discussed.

726 Varitrons. A. Papkow. Physik. Blätter 5, 206-10 (1949)(in German).

This is a review, containing 10 references to the original articles published in Russian journals, of recent cosmic-ray work of Alikhanov, Alikhanyan, and their co-workers, who, by means of magnetic spectrometers, found charged cosmic-ray particles with masses 100, 150, 180, 200, 260, 350, 500, 660, 950, 2200, 3400, 8000, and 20,000 times that of the electron. Those heavier than protons (both negative and positive) are called varitrons by their discoverers. Their half-lives are estimated to be at least of the order of 10^{-8} sec, but possibly as large as 10^{-6} sec. The experimental arrangement of the magnetic spectrometers used is described in some detail. A magnetic field of 7300 Oersted is supplied by a permanent magnet with pole faces 70 × 30 cm in area, and 8 cm apart. This field deflects particles coming from above, which have traversed a number of lead filters and counters, connected by coincidence circuits. A schematic diagram of the arrangement is given. From the deflection spectrum of the particles and the thickness of lead traversed, their masses are deduced.

727 Wide Angle Sprays of Minimum Ionization Particles. F. Oppenheimer and E. P. Ney. Phys. Rev. 76, 1418-19(1949) Nov. 1 (Letter to the editor).

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Wide angle sprays of soft minimum ionization particles have been observed emerging from lead plates in a cloud chamber. Pictures were taken for 3 hr at a rate of 1/min at an altitude of 14 g/cm² and 55 deg. geomagnetic latitude. A photograph of one of the largest sprays containing about 30 tracks (probably electrons) is reproduced, and data on all sprays observed is tabulated. Some of the sprays appear to emerge from stars, and the others may have the same origin. Several groups of tracks with different origins appear in each spray, emerging from a region in the plate about 1/2 cm in diameter. It was not possible to determine the origin of the sprays. The momentum of the spray particles will be determined in future work.

728 Linear Amplifiers. M. A. Schultz. AECD-2754, nd. Decl. Dec. 7, 1949. 46p.

The problems in the design of linear pulse amplifiers are presented from the point of view of the radio engineer. Equations are given for the noise generated in the input circuits of these amplifiers for ideal cases. Typical amplifying circuits are presented, and the solutions of the design problems are illustrated by the circuit diagrams and performance of a commercial linear amplifier. 11 references.

729 Area Measuring Device and Method. Marietta Blau and Jack Raymond Carlin (to Canadian Radium and Uranium Corp., New York). U. S. Patent 2,462,351, Feb. 22, 1949.

A method for the measurement of the areas of irregular bodies is presented. The apparatus described consists of two parallel plates or electrodes separated by an ionizable medium at 760 mm Hg and at a temperature of 20°C; a low voltage potential is applied across the electrodes and a sheet of foil coated with polonium (for α-ray emission) is placed over the face of the emitting electrode. The α particles partially ionize the medium so that there are lines of force between the two electrodes in the form of a beam. When a thin, bendable test body (smaller than the beam dimensions) is placed in the beam path a decrease in the charge of the system occurs varying with the area of the test body.

730 Notes on the Design and Construction of Regulated Power Supplies. James L. Lawson. MIT-RL-44, Feb. 26, 1945. 10p.

Design considerations for an electronically regulated d-c voltage supply are given. Practical difficulties in obtaining optimum performance and low hum level are discussed. A typical circuit for a well regulated supply is attached which delivers 250 v with a hum level of less than 0.3 millivolt rms.

731 Protection of Optical Instruments by Radium Emanations. Richard E. Vicklund. U. S. Patent 2,478,955, Aug. 16, 1949.

In order to protect lenses and optical instruments against discoloration, clouding or etching due to fungi, the inventor devised the following procedure: a thin coat of radioactive α-ray emitter, such as radium, is spread in the concentration of 8-15 μg/sq in. on metal foil; the foil is then placed

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on the rim of the optical instrument with the coated side facing inward, and sterilization of the surface of the lens occurs up to 2.5 in. away, all fungi present being destroyed.

732 Target Indicator. Allen C. Stephens. U. S. Patent 2,486,503, Nov. 1, 1949.

This invention is an x-ray target indicating device which includes means for projecting a beam of visible light along the proposed path of the x-ray beams; an improved terraced housing for the unit is claimed, which incorporates a number of surfaces spaced at right angles to the axis of the beam and which are adapted to conform to the diameters of the bases of different x-ray focusing cones.

733 On the Occurrence of Vanadium 50 in Nature. David C. Hess, Jr., and Mark G. Inghram. AECU-639(UAC-168), Oct. 21, 1949. 3p.

This is not an abstract; the document is reproduced below in its entirety.

The isotopic composition of vanadium was first studied by Aston (Phil. Mag. 47, 397(1924)) who showed it to consist principally of V^{51}. No work has since been reported on the naturally occurring isotopes of this element. The artificially produced radioisotopes of vanadium listed by Seaborg and Perlman are: V^{47}-33 min, V^{48}-16 days, V^{49}-600 days, and V^{52}-3.8 min (Rev. Mod. Phys. 20, 593(1948)). Recently Cork, Keller, and Stoddard have observed 635-day and 16-hr activities in vanadium which had been subjected to neutron bombardment in the Clinton pile (Phys. Rev. 76, 575(1949)). The production of the 600-day activity by pile neutron irradiation of V^{51} is inconsistent with the assignment of this activity to V^{49}. As has been pointed out to us by Katharine Way, one of the possible explanations for this inconsistency is that vanadium has more than one naturally occurring isotope. This possibility is also indicated by consideration of the curve of greatest stability.

In order to test this hypothesis the isotopic composition of vanadium has been restudied and a new isotope found to be present at mass 50. The results are tabulated in Table 1. Two 60-deg. single focussing mass spectrometers were used, one equipped with a standard electron bombardment type of source and the other with a surface ionization source in which the vanadium was ionized by evaporation from a hot platinum filament. In the case of the source using electron bombardment the ratio of the abundance of the isotope at mass 50 to the one at mass 51 was determined from three different ion groups, V^+, V^{++} and VCl^{++}. In the case of the surface ionization source two ion groups were used, V^+ and VO^+. The fifth column lists the ratios observed in the five cases studied along with the mean deviation of the results.

Table 1 — Abundance of the Vanadium Isotopes

Ion source	Sample form	Ion group studied	No. of results	Observed 50/51 × 100	Impurity peaks
Electron bombardment	$VOCl_3$	V^{++}	13	0.274 ± 0.004	C_2
	$VOCl_3$	V^+	8	0.256 ± 0.004	---
	$VOCl_3$	VCl^{++}	12	0.254 ± 0.005	---
Surface ionization	V_2O_5	V^+	19	0.268 ± 0.026	Cr^+
	V_2O_5	VO^+	29	0.271 ± 0.027	Zn^+

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The sixth column lists the ions of impurities for which small corrections must be applied to the observed ratios. These corrections amount to about 0.018, 0.027, and 0.013 in the cases of C_2^+, Cr^+, and Zn^+, respectively. The results indicate that V^{50} exists in nature to about 0.25%. This conclusion is confirmed by the fact that the abundance ratios measured with five different ions are consistent, and that two different types of sources gave the same results. In addition two samples of different chemical purity gave the same result, and the ratio was found to be independent of sample pressure and peak intensity. Finally, large fractionations of adjacent elements were observed with time with the surface ionization source, but no fractionation was detectable in the 50/51 ratio. All of these facts would be extremely improbable unless both peaks were due to the same element.

The probable explanation of Cork's results are that the 635-day activity was produced by an (n,2n) reaction on V^{50}, and that the 16-hr activity is an excited state of V^{50}.

Further work is in progress in an attempt to detect natural radioactivity in V^{50} and to determine more carefully the abundance of this isotope.

734 Isotopic Composition of Sulfur in Meteorites and Terrestrial Objects. A. Trofimov. Doklady Akad. Nauk S.S.S.R. 66, 181-4(1949)(in Russian).

Many attempts to find differences in the isotopic composition of elements on earth and in meteorites invariably gave negative results. The elements hitherto studied were Fe, Ni, Cl, Si, C, O, K^{40}, Cu, Ga, (references given). The author reports on a mass-spectrographic investigation of sulfur from four meteorites and four terrestrial sources. The meteoritic sulfur was that of the mineral troilite, a ferrous sulfide, isolated from two stony and two iron meteorites. The material employed for the mass-spectrographic analysis was SO_3, the ion used for the measurements SO^+. The relative error in the determination of the ratio S^{34}/S^{32} is less than 1%; that of S^{33}/S^{32} is about 2-3%; the content of the rare S^{36} could not be determined. The following table shows the results:

Meteorites	S^{34}: S^{33}: S^{32}	Terrestrial	S^{34}: S^{33}: S^{32}
Stone	4.53:0.78:100	Sea water	4.60:0.81:100
Stone	4.56:0.79:100	Volcanic S	4.56:0.81:100
Iron	4.56:0.79:100	Pirite	4.56:0.80:100
Iron	4.54:0.79:100	H_2SO_4	4.56:0.79:100

The compositions are substantially identical. In sea water there is a slight enrichment in the heavy S^{34}. The mean of all determinations is 4.56:0.80:100; that given by Nier is 4.4:0.78:100 (Phys. Rev. 53, 282(1938)); Nier estimated the accuracy of his analyses as ±2%.

735 A Naturally Occurring Odd-Odd Isotope of Vanadium. Wallace T. Leland. Phys. Rev. 76, 1722-3(1949) Dec. 1 (Letter to the editor).

By means of a mass spectrometer of a design similar to that of Nier (Rev. Sci. Instruments 18, 398(1947)), the author found an isotope of vanadium of mass 50 having an abundance of 0.23 ± 0.01%. A check by means of thin walled β counters

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as well as with photographic plates failed to detect any radioactivity of V^{50}.

736 A New Regularity in the Abundance Distribution of Isotopes — the N_4 Effect. O. Monecke. Experientia 5, 232-3(1949) June 15 (Brief report, in German).
In connection with the observed regularities in the abundance of isotopes, the experimental evidence is discussed for the assumption that shells composed of four neutrons (N_4) are especially stable.

737 Relative Abundance of the Isotopes of Tin. H. Hintenberger, J. Mattauch, and W. Seelmann-Eggebert. Z. Naturforsch. 3a, 413-15(1948) July (in German).
The relative abundances of the Sn isotopes has been redetermined using an electrometric method. The following results were obtained: 112(0.94%), 114(0.65%), 115(0.33%), 116(14.36%), 117(7.51%), 118(24.21%), 119(8.45%), 120(33.11%) 122(4.61%), 124(5.83%). Using these relative abundances, the mass number is 118.826 ± 0.009, which, with a packing fraction of −5.07 ± 0.32 gives 118.73 ± 0.01 for the atomic weight of Sn. The international value is 118.70. The upper limit of the abundance of the isotopes of mass number 110, 111, 113, 121, 123 and 125 is 0.01%. It is noted that the abundance values obtained differ considerably from those obtained by Aston using photometric methods.

738 A Table of Relative Abundances of Nuclear Species. Harrison Brown. Revs. Modern Phys. 21, 625-34 (1949) Oct.
The available information on the abundances of nuclear species existing in nature is summarized. Data used were primarily those obtained from a consideration of the composition of meteorites; if these were not available, of the composition of stars and the sun. The following tables are given: Stellar abundances of the lighter elements (atoms per atom of oxygen); Abundances of elements in meteoric phases (per cent by weight); Elemental abundances (atoms per 10,000 atoms of Si); Relative abundance of nuclear species (atoms per 10,000 atoms of Si); Cosmic abundances of the rare gases as estimated by interpolation of the abundance curves (abundances in atoms per 10,000 atoms of Si); Abundances of elements in interstellar material.

739 Ion Migration in the Counter-Flow as a Basis for an Electrochemical Exchange Method. Hans Martin. Z. Naturforsch. 4a, 28-37(1949) Apr. (in German).
The principle and theoretical foundations are given for an electrolytic counter-flow method for the enrichment of isotopes. The individual separation factor (q) is caused by a chemical exchange equilibrium between ions and neutral particles (or between different kinds of ions) of an isotopic electrolyte in solution. The counter-flow causing a multiplication of the individual separation effect to give a separation factor $Q(= q^f)$ is caused by ionic migrations in a flow of fluid of such a magnitude that the material subject to the separation process suffers no net transfer. The method is discussed for the exchange equilibrium of the type $^*M^+ + MX = M^+ + {}^*MX$ with particular reference to the electrolysis of an $MgSO_4$ solution. For the multiplication possible with this method calculation gives unusually high values. The final separation factor Q_e is then calculated without regard to the relaxation time of the exchange reaction. It follows that Q goes through a maximum with increasing magnitude of electrolysis field strength. From the optimum value of the field strength it is possible to draw conclusions concerning the velocity of the assumed ion exchange reaction, which thus becomes measurable.

740 Photoneutrons from Neutron Capture Gamma Rays. Bernard Hamermesh and Albert Wattenberg. AECU-594(UAC-159), Sept. 19, 1949. 1p.
This is not an abstract; the document is reproduced below in its entirety.

Recent reports (Kubitschek, et al, Phys. Rev. 76, 531(1949)) on γ-rays produced on neutron capture indicate that gamma rays of energies as high as 9.5 Mev are produced. Since neutron binding energies are usually between 6 and 8 Mev, the capture γ rays from some substances should be able to photodisintegrate other substances.

A neutron beam from the thermal column of the Argonne heavy water pile was allowed to impinge upon various materials such as Cd, Cl (C_2Cl_4), Au, and Fe. The gamma rays emitted then struck various possible (γ,n) sources placed next to a detector. The detector was a BF_3 pulse ion chamber embedded in paraffin. The counter was well shielded from fast neutrons from the pile. Cadmium differences were measured with different combinations of source and target. The following table shows the cadmium differences obtained in counts/min after correcting for various backgrounds.

TABLE
Cadmium differences in counts/min

Targets / gamma ray sources	Cl	Cd	Au	Fe
D_2O	470	1000	270	130
Pb	110	15	25	
Bi	25	15	15	
Hg	20	10	0	
Li(LiF)	20	10	35	
Fe	0	0		
Al	0	0		
Cd	0	0		

The statistical accuracy is ±10 counts/min. Values other than zero are given only where a consistently positive effect was found. The efficiency of the detector was such that one millibarn (γ,n) cross section was the lowest that could give a positive effect, assuming that 1% of the capture γ rays are effective. As more information is obtained about capture γ-ray spectra, it may be possible to obtain values of photodisintegration thresholds and cross sections for various elements in the region 6-10 Mev. With the present available thermal neutron beams, the above reactions do not seem to be useful sources of fast neutrons.

741 The Angular Distribution of the Photoneutrons from Deuterium at 2.76 Mev. Bernard Hamermesh and

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Albert Wattenberg. AECU-595(UAC-158), Sept. 19, 1949. 1p.

This is not an abstract; the document is reproduced below in its entirety.

The apparatus and techniques used in the study of the photoneutrons from beryllium (B. Hamermesh et al, Phys. Rev. 76, 611(1949)) have been used to study the photoneutrons produced in deuterium by 2.76 Mev γ-rays. The distribution is found to be of the form $I(\theta) = a + b \sin^2 \theta$. The ratio a/b is best found by measurements made at 0 deg. and 90 deg. The results are subject to two corrections, a geometrical one caused by the finite angles subtended by the source and counter at the target, and a correction caused by neutrons being scattered inside the D_2O target. The former correction is readily estimated from the relative dimensions and spacings of the target, source, and counter. The scattering correction may be estimated in a very rough manner (ibid.). However, because of the large effect of this correction of the a/b value for deuterium, an experimental study was made of the correction.

The method used is similar to the one of Graham and Halban (Rev. Mod. Phys. 17, 297 (1945)) and Meiners (Phys. Rev. 76, 259(1949)). Since the scattering effect should become smaller and smaller as the size of the D_2O target decreased, a set of D_2O targets of varying diameters was used. The cylindrical D_2O holders were made of steel tubing 0.0125 cm thick and 5 cm long. The outer diameters were 4.5, 6, 9, and 12 mm, respectively. Column II of the table shows the values of I_0/I_{90} for the different targets obtained on different runs lasting 12-24 hr. In column III are the average values for a given diameter of the results in Column II corrected for geometry.

TABLE

I	II	III
Diameter of D_2O holder	I_0/I_{90}	I_0/I_{90} corrected for geometry
12 mm	0.393	
	0.354	
	average 0.374 ± 7%	0.350
9 mm	0.318	
	0.361	
	0.347	
	0.357	
	average 0.346 ± 6%	0.321
6 mm	0.245	
	0.304	
	0.364	
	0.279	
	average 0.298 ± 16%	0.271
4.5 mm	0.299	
	0.282	
	0.264	
	0.257	
	0.354	
	average 0.276 ± 19%	0.248

Assuming a linear dependence on radius of I_0/I_{90}, the extrapolated value for zero radius is 0.17. This yields a value of a/b of 0.205 + .05. The value previously reported by us (B. Hamermesh and A. Wattenberg, Phys. Rev. 75, 1290(A)(1949)) was not corrected properly. The present value is in agreement with Lassen's (Phys. Rev. 75, 1099(1949)) corrected value and with Meiner's value.

742 Elastic Scattering of 84-Mev Neutrons. A. Bratenahl, S. Fernbach, R. H. Hildebrand, C. E. Leith, and B. J. Moyer. AECU-625(UCRL-431), Aug. 25, 1949. 31p.

Measurements have been made of the angular distribution of 84-Mev neutrons scattered into angles between 2 1/2 and 25 deg. by Al, Cu, and Pb nuclei. Small spheres of these elements were placed in the neutron beam of the 184-in. cyclotron, and the scattered neutrons with energies greater than 20 Mev were detected with pieces of carbon activated by the $C^{12}(n,2n)C^{11}$ reaction. Total scattering cross sections were obtained by integration of the differential scattering cross sections and also by attenuation measurements with good and poor geometry. The results are compared with the total collision cross sections determined by Cook et al (Phys. Rev. 75, 7(1949)) and by the authors, using the same beam and the same detectors. 12 references.

743 Angular Distribution of Neutrons from the Photo-Disintegration of the Deuteron. Frank Genevese. Phys. Rev. 76, 1288-94(1949) Nov. 1.

The angular distribution of neutrons arising from the photodisintegration of deuterons by γ rays of 2.76 Mev energy has been investigated under conditions requiring no corrections for neutron scattering by the walls or by the heavy water. Inverse square law tests using balloon suspension indicated the clearance required for which the apparatus was free of the effects of scattering. The weighted ratio of the photomagnetic to the photoelectric cross sections was found to be 0.295 ± 0.036. 11 references.

744 The Attenuation of Neutrons of Various Energies in Water. C. E. Falk and E. Creutz. J. Applied Phys. 20, 1183-5(1949) Dec.

Threshold detectors (In^{115}, Ag^{107}, and C^{12}) were used to determine the relative intensities of neutrons at various distances inside a large water tank. Neutrons with energies up to 30 Mev were produced by (d,n) reactions. At distances in the water > 20 cm the "half-thickness" of water was found to be almost independent of neutron energy (about 8 cm).

745 Elastic Scattering of Neutrons by Atomic Nuclei. T. A. Goloborod'ko. Uspekhi Fiz. Nauk 37, 414-57 (1949)(in Russian).

In a critical review of the experimental work done on the elastic scattering of neutrons, in connection with the general problems of the structure of the nucleus, the author first surveys the determinations of the relationship $\sigma = f(A)$, where σ is the cross section for the elastic scattering and A is the atomic mass number of the scatterer. The contribution of Russian workers was a series of determinations of this relationship by using photoneutrons in the energy interval 0.1 to 0.5 Mev (the latest cited is: Goloborod'ko, Doklady Akd. Nauk S.S.S.R. 30, 307(1941)). The general picture empirically obtained, in the range between 90 Mev and the en-

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ergy of thermal neutrons, is a scattering of σ values, with increasing A, around an approximately rectilinear graph, this scattering increasing regularly with the decreasing energy of the neutrons. These regularities, which must be attributed to resonance interactions, show the inadequacy of the simple drop model of the nucleus. The same impression of a significant part played by resonance phenomena is gained from the survey of the determinations of $\sigma = f(E)$, where E is the energy of the neutrons; however, there is a notable discrepancy between the known theoretical evaluation of these phenomena and the values observed: it seems that in all nuclei, not only in the light ones, there exist widely separated resonance levels, with intervals reaching several hundred kev. This leads to a model of the nucleus in which a shell, consisting probably of α groupings, is differentiated from an inner "subnucleus" composed of the remaining neutrons; the shell, and sometimes even only one of its α groups, would interact with the impinging particles. The scattering of neutrons by protons is examined in a separate chapter: The numerous discrepancies are cited between the Bethe-Peierls formula for $\sigma = f(E)$ and the experiment. The author's own work (Zhur. Eksptl. i Teoret. Fiz. 14, 247(1944)) showed that at low energies the theoretical curve should be replaced by one containing two minima, at 0.2 and 0.4 Mev. The contradicting answers, given by many investigators to the question of the angular distribution (spherical or asymmetric) of the scattered neutrons, have motivated the author's study (Zhur. Eksptl. i Teoret Fiz. 17, 945(1947)), in which, by using only 0.2-Mev neutrons, he demonstrated an asymmetric distribution with maxima at 45 and 135 deg. and minima at 90 and 180 deg. The last section is devoted to the interaction of high energy neutrons with protons, in connection with the meson theories of nuclear forces.

746 Neutron Polarization. J. Fleeman, D. B. Nicodemus, and H. H. Staub. Phys. Rev. 76, 1774-81(1949) Dec. 15.

Experiments for the determination of the polarization cross section p of iron with monochromatic and nonmonochromatic neutrons are described. The absolute value of p as well as its dependence on the neutron velocity is found to be in good agreement with the recent calculations of Steinberger and Wick (Phys. Rev. 74, 1207(1948)) and also with other experiments. For a complex neutron spectrum originating from a paraffin moderator $\bar{p}$ is found to be $(2.35 \pm 0.1) \times 10^{-24}$ cm^2 in agreement with previous investigations. It is shown that the larger value of 3.15×10^{-24} cm^2 found by Hughes et al (Phys. Rev. 73, 1277(1948)) must be due to spectral differences. The approach of the magnetization of iron toward saturation is also investigated. 13 references.

747 Neutron-Proton and Proton-Proton Cross Sections at 83 Mev. L. Castillejo and H. T. Richardson. Phys. Rev. 76, 1732-3(1949) Dec. 1 (Letter to the editor).

Results are given of the calculation of the total and differential cross section for neutron-proton, proton-proton, and neutron-neutron scattering at an energy of 83 Mev. They are based on square well potentials with the following two sets of force constants:

	r_0	r_c	r_t	V_0	V_c	V_t
(1)	2.8	1.6	3.08	11.9	39.3	10.04
(2)	2.8	0	3.27	11.9	$v_1 = 4.49 \times 10^{11}$ cm^{-1}	9.62

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where r is the range of the force in units of 10^{-13} cm, V is the depth of the well in Mev, and the subscripts o, c, t denote singlet, central force triplet, and tensor force triplet interaction.

748 Neutron-Proton Scattering. H. N. Yadav. Phys. Rev. 76, 1720-1721(1949) Dec. 1 (Letter to the editor).

Calculations were made of neutron-proton scattering using a two-range Yukawa well with ranges 0.80×10^{-13} cm and 1.60×10^{-13} cm for the central and tensor forces, respectively. The appropriate constants were determined by the iteration method for these ranges to agree with the binding energy and electric quadrupole moment of the deuteron. For the singlet interaction a range of 1.18×10^{-13} cm was used to fit the data on p-p scattering. The low energy total scattering cross section for incident neutrons of energy 0-3 Mev are in agreement with experimental results, but the high energy (83 Mev) cross sections are found to be too large (14.6×10^{-26} cm) for the symmetrical interaction and 12.1×10^{-26} for the Serber type of interaction. Angular differential cross sections are also given for these two cases. Finally, the authors find that the Born approximation for high energy scattering in the triplet states gives a much smaller cross section than that obtained by the exact calculation.

749 Thermal Neutron Cross Sections and Related Data. H. R. Kroeger. Nucleonics 5, 51-4(1949) Oct.

A convenient summary of some declassified data on thermal neutron cross sections and general nuclear data has been arranged in tabular form. Included in the table (in which the elements are listed by atomic number) are data on the following: chemical atomic weight, density, nuclei/cm^3; average log energy loss, thermal neutron cross sections, thermal macroscopic cross sections, thermal mean free path, slowing down power, and moderating ratio. Tabulated values are also given for (1-b), in which "b" is the average cosine of the scattering angle relative to the initial direction. The cross sections for the various types of collisions, i.e., scattering, transport, and absorption, are noted.

750 Velocity Dependence of the Absorption of Thermal Neutrons. Wolfgang Ramm. Z. Naturforsch. 4a, 245-57(1949) July (in German).

The decrease of density of thermal neutrons in the neighborhood of an absorber was determined at room temperature and at 200°C. It was possible to determine from this decrease the energy dependence of the capture cross section in the thermal region, practically regardless of the value of the scattering cross section. Measurements were made using boron, chlorine, manganese, iron, cobalt, copper, silver, cadmium, samarium, europium, gadolinium, dysprosium, and mercury.

751 Atomic Beam Magnetic Resonance Experiments with Radioactive Elements Na^{22}, K^{40}, Cs^{135}, and Cs^{137}. Luther Davis, Jr., Darragh E. Nagle, and Jerrold R. Zacharias. Phys. Rev. 76, 1068-75(1949) Oct. 15. (See also NSA 1-1889; 3-1409.)

Modifications of the atomic beam magnetic resonance method for the determination of nuclear spins and moments by ob-

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servation of the hyperfine structure of atomic ground states are described, which make it possible to work with very small quantities in samples with low concentrations. These modifications include the analysis of the beam by means of a mass spectrometer while performing the resonance experiment. A new source of beams of atomic alkali metals is described. The results are shown in the following tabulation:

	Spin	h.f.s.$\Delta\nu$ Mc/sec	Nuclear magnetic moment nuclear magnetons
Na^{22}	3	1220.64 ± 0.04	1.746 ± 0.003
K^{40}	4	1285.73 ± 0.05	−1.290 ± 0.005
Cs^{135}	7/2	9724 ± 8	2.724 ± 0.010
Cs^{137}	7/2	10,126 ± 7	2.837 ± 0.010

20 references.

752 The Atomic Nucleus. Andre Berthelot. Paris, Centre National de la Recherche Scientifique, 1948. 32p. (in French).

The three parts of this booklet concern the stable nucleus, beta radioactivity, and fission of the uranium nucleus.

753 Concerning the Interpretation of "Magic" Nucleon Numbers in Connection With the Structure of Atomic Nuclei. Otto Haxel, J. Hans, D. Jensen, and Hans E. Suess. Naturwissenschaften 35, 376(1948)(Brief note, in German) (See also NSA 3-993.)

Nuclei in which protons or neutrons occur in the following numbers, are especially stable: 2, 6, 8, 14, 20, 28, 40, 50, 70, 82, 92, 112, 126. The authors attempt to explain this by devising a clarification scheme for nuclear states, based on considerations of angular momentum.

754 The Effect of Nuclear Motion on Atomic Magnetic Moments. M. Phillips. Phys. Rev. 76, 1803-4(1949) Dec. 15.

The effect of the finite mass of the nucleus on the Zeeman pattern of multi-electron atoms is investigated. This effect consists of two parts, one due to the motion of the core and nucleus about the center of mass, the other an exchange phenomenon between the electrons themselves. Both are of order m/M, where M is the mass of the nucleus.

755 The Energy Level Density and Partition Function of Nuclei. D. ter Haar. Phys. Rev. 76, 1525-6(1949) Nov. 15.

The nuclear energy level densities given by van Lier and Uhlenbeck (Physica 4, 531(1937)), and by Bohr and Kalckar (Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd. 14, No. 10 (1937)) are compared with those given by Wergeland (Fysik, Verden, 223(1945)). It is shown that Wergeland's formula agrees slightly better with the observational data. Wergeland's energy level density is then used to calculate the partition function of nuclei at a temperature of 1 Mev since this partition function enters into a discussion of the equilibrium theory of the origin of the chemical elements.

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756 Energy Levels of Atomic Nuclei. V. N. Kondrat'ev. Uspekhi Fiz. Nauk 38, 153-221(1949)(in Russian).

In this review of literature on energy levels of atomic nuclei (259 references), a short introduction shows the inadequacy of present-day theories in their attempt to account for the quantitative aspects of the problem; the following section is an enumeration of principles of different experimental methods leading to the determination of energy levels; the work ends with an extensive table of energy levels of various nuclei, compiled from data published before January 1, 1949.

757 Erratum: Our Knowledge of the Atomic Constants F, N, m, and h in 1947, and of Other Constants Derivable Therefrom (Revs. Modern Phys. 20, 82(1948). J. W. M. DuMond and E. Richard Cohen. Revs. Modern Phys. 21, 651-2(1949) Oct.

The value of h_0 used to compute the least squares fitted value of the Planck constant from the relation $h = h_0(1 + \bar{x}_h \cdot 10^{-6})$ was incorrect. The correct values are: $h_0 = 6.63430 \times 10^{-27}$ erg sec, $\bar{x}_h = -15.93$, $h = 6.62373 \times 10^{-27}$ erg sec. The value of h is raised one part in 22,000 above that given previously. The least squares fitted values of the atomic constants, whose computation involved h were also revised and a corrected version of Table VIII is given (Essentially 1947 values corrected March 18, 1949, for a small numerical error.).

758 Hyperfine Structure and Nuclear Spin of Kr^{83} and Ne^{21} Investigated with Separated Isotopes. Jørgen Koch and Ebbe Rasmussen. Phys. Rev. 76, 1417 (1949) Nov. 1 (Letter to the editor).

Highly enriched samples of Kr^{83} and Ne^{21}, prepared by means of a mass spectrograph, were investigated concerning hyperfine structure, and their spin was checked from the interval rule. For Kr^{83}, a spin value 9/2 was established, which agrees with previous determinations. The existence of a quadrupole moment of Kr^{83} was also confirmed. It was found that Ne^{21} has a negative magnetic moment and a spin of 3/2 or more. Further details will be published.

759 The Hyperfine Structure of the $^2P_{3/2}$ State of Al^{27}. The Nuclear Electric Quadrupole Moment. Hin Lew. Phys. Rev. 76, 1086-92(1949) Oct. 15. (See also NSA 2-232.)

The hyperfine structure of the $3p\ ^2P_{3/2}$ state of Al^{27} has been measured by the atomic beam magnetic resonance method. The magnetic dipole and electric quadrupole interaction constants a and b have been found to be:

$$a = 94.25 \pm 0.04 \text{ Mc/sec}, \quad b = 18.76 \pm 0.25 \text{ Mc/sec}.$$

From these, the electric quadrupole moment of the nucleus has been calculated to be

$$Q = (0.156 \pm 0.003)10^{-24} \text{ cm}^2.$$

760 Magnetic Moment of La^{139}. W. C. Dickinson, Phys. Rev. 76, 1414-15(1949) Nov. 1 (Letter to the editor).

The ratio of the frequency of the nuclear magnetic resonance of La^{139} to that of the proton has been measured at 6700 gauss.

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Resonances were observed in an aqueous solution of LaCl, by a method similar to that of Dickinson and Wimett (Phys. Rev. 75, 1769(1949)). Since the line width was about three gauss, frequency measurements could be made with the Zenith BC-221-T frequency meter. The magnetic moment of La^{139} was found to be $\mu(La^{139})/\mu(H^1) = 0.98876 \pm 0.00010$. This result is uncorrected for the diamagnetic field at the nucleus.

761 Mass-Defect Curves. A. M. Mosharrafa and M. el Nadi. Nature 164, 662-3(1949) Oct. 15 (Letter to the editor).

The empirical curve of the mass defect as a function of the mass number based on the data given by Rosenfeld (Nuclear Forces, 24(1948)) is compared with a curve calculated by Nadi from the relationship $\epsilon = \frac{W - Zm_p - Nm_n}{A}$, where m_p and m_n are the atomic weights of a proton and neutron, Z and N are the number of protons and neutrons, respectively, and W is the atomic weight. The empirical curve shows the periodicity of four very clearly for the lighter nuclei, although the calculated curve does not show this effect. It is also noted that the calculated curve rises less steeply than the empirical one at the end, giving lower values for (W-A).

762 Molecular Dipole Moments and Stark Effects. I. Stark Effects on Symmetric Top Molecules with Nuclear Quadrupole Coupling. W. Low and C. H. Townes. Phys. Rev. 76, 1295-9(1949) Nov. 1.

The hyperfine structure of rotational levels of a symmetric top molecule in which one nucleus has an electric quadrupole moment is derived for weak, strong, and intermediate fields. Intensities of the hyperfine components are discussed. Solution of a second-order secular equation is shown to suffice for the evaluation of dipole moments from microwave spectra. A sample calculation is given for a nuclear spin of 3/2 and J = 1 – 2 transition.

763 Notes on the j-j Coupling Shell Model. Eugene Feenberg. Phys. Rev. 76, 1275-8(1949) Nov. 1.

A study of the nuclear shell model based on the hypothesis of strong spin-orbit coupling yields a number of interesting results for even-even and odd-odd nuclei. To secure simple relations all calculations are based on the extreme limiting situation of complete j-j coupling. Maximum symmetry in the space wave function and j-j coupling are generally in sharp conflict. On occasion there is no conflict and then the consequences of the j-j coupling model are found to agree with experiment (notably the spin and magnetic moment of B^{10} and the sign of the magnetic moment of K^{40}). The j-j coupling model yields good results for the magnetic moments of N^{14} and Ne^{22}, but in both cases the agreement may be illusory because the computed moments are nearly independent of the amount of singlet wave function in the representation of the ground state. Also the model favors I = 5 for the ground state of Na^{22}. 25 references.

764 The Nuclear Gyromagnetic Ratio of V^{51}. W. D. Knight and V. W. Cohen. Phys. Rev. 76, 1421(1949) Nov. 1 (Letter to the editor).

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Assuming a probable value of 7/2 for the nuclear spin, the nuclear magnetic moment of V^{51} has been determined as 5.150 nuclear magnetons on the basis of resonances observed in $Pb(VO^3)_2$ and in V_2O_5, using an automatic recording r-f spectrometer similar to that described by Pound (Phys. Rev. 72, 527(1947)); the compounds were used both in the dry powder form and in acid solutions. The resonance frequency for V^{51} was compared to that for Na^{23}, for fixed magnetic field, in a mixture containing V_2O_5, NaCl, and dilute HCl. The ratio of the uncorrected g values is given by the observed frequency ratio, which is:

$$g(V^{51})/g(Na^{23}) = 0.99394 \pm 0.00003.$$

Using Bitter's (Phys. Rev. 75, 1326(1949)) value for the frequency ratio Na^{23}/H^1, and the value of Taub and Kusch (Phys. Rev. 75, 1481(1949)) for $g(H^1) = 5.5870$ nuclear magnetons, the frequency ratio V^{51}/H^1 and $g(V^{51})$ are, respectively: $V^{51}/H^1 = 0.26290$, $g(V^{51}) = 1.4713 \pm 0.0003$ nuclear magnetons. The value of the nuclear magnetic moment was determined from this.

765 Nuclear Induction and Beat Phenomena. C. R. Extermann, P. Denis, and G. Béné. Helv. Phys. Acta 22, 388-90(1949)(in French).

The form of nuclear induction signals, particularly the number and amplitude of beats, depends on a parameter which is itself a function of the transverse relaxation time, and on the time derivative of the magnetic field at resonance. The theoretically predicted form of this relationship was confirmed experimentally for aqueous solutions of chrome alums of known concentrations.

766 Nuclear Magnetic Resonance at Low Temperatures. J. Hatton and B. V. Rollin. Proc. Roy. Soc. 199 A, 222-31(1949) Oct. 25.

Investigations have been made on nuclear paramagnetism at low temperatures by the radio-frequency resonance absorption method. In measurements on solid hydrogen it has been found that there are considerable changes in the width of the resonance line with change of temperature. These effects are related to changes in the nature of the molecular motions and the state of the molecular order. A number of experiments have been made on nuclear spin-lattice relaxation in different substances. It has been shown that in ionic crystals the nuclear relaxation is greatly affected by the presence of paramagnetic impurities. The nuclear relaxation time in metals has been found to be in reasonable agreement with theoretical predictions. Measurements have been extended to temperatures below 1°K, and the possibility of cooling the nuclear spin system by adiabatic demagnetization has been verified. The results for nuclear spin-lattice relaxation are considered in relation to the possible applications of nuclear paramagnetism in the region of very low temperatures. 28 references.

767 Nuclear Moments of Mg^{25}. M. F. Crawford, F. M. Kelly, A. L. Schawlow, and W. M. Gray. Phys. Rev. 76, 1527-8(1949) Nov. 15 (Letter to the editor).

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The Mg I lines 5184, 5173, and 5167 A and the Mg II resonance line 2796 A have been excited in an atomic beam light source and their hyperfine structures resolved with a Fabry-Perot etalon. The structures show that for Mg^{25} I = 5/2 and the nuclear magnetic moment is negative and equal to -0.96 ± 0.07 nuclear magnetons. The spin and the negative sign of the magnetic moment agree with the predictions of the shell structure in nuclei. (Feenberg and Hammack, Phys. Rev. 75, 1877(1949) and Nordheim, Phys. Rev. 75, 1894(1949)). The magnitude of the magnetic moment falls near the average curve for similar nuclei in a Schmidt diagram, but as for most of these nuclei it does not agree with the value predicted by an individual particle model.

768 Nuclear Moments of $_{39}Y^{89}$. M. F. Crawford and N. Olson. Phys. Rev. 76, 1528(1949) Nov. 15 (Letter to the editor).

Lines in the first, second, and third spectra of yttrium have been examined for hyperfine structure (Schüler and Schmidt, Naturwissenschaften 22, 838(1934); Williams and Graneth, Phys. Rev. 54, 338(1938); Wittke, Z. Physik 116, 547(1940); Kruger and Challacombe, Phys. Rev. 47, 509(1935); 48, 111 (1935)) but none has been observed. Wittke concluded that $\mu \leq 0.1$ n.m. on the assumption that I = 1/2. In the present investigation, the Y III resonance line 2817 A has been resolved into two components. The observed intensity ratio is 3:1, and the fainter component is of lower frequency. Thus I = 1/2, and the magnetic moment is negative. The magnetic moment calculated from the observed separation of the two components is $\mu = -0.14$ nuclear magnetons. The Y III spectrum was excited in the electrodeless discharge described by Crawford and Levinson (Can. J. Research 27 A, 156(1949)) and the 2817 A line was resolved with a 3 cm Fabry-Perot etalon. The conclusions are in fair agreement with the predictions of a one particle model.

769 Nuclear Physics for Engineers. Robert J. Creagan. M-4437, Westinghouse Electric Corp. 1949. 160p.

This course in nuclear physics contains 12 lectures on the following subjects: history, units, definitions, elementary particles; radioactivity; cross sections; nuclear reactions; general properties of nuclei; range-energy relation, interaction between radiation and matter; detection of nuclear particles; special relativity and nuclear physics; nuclear fission; neutron physics; introduction to quantum mechanics. 14 references.

770 Nuclear Quadrupole Moments and Nuclear Shell Structure. C. H. Townes, H. M. Foley, and W. Low. Phys. Rev. 76, 1415-16(1949) Nov. 1 (Letter to the editor).

Schmidt (Naturwissenschaften 28, 565(1940)) has found a systematic variation with Z of the deviation of nuclear charge distributions from a sphere, and his plot has been extended by more recent work (Mattauch and Flügge, Nuclear physics tables and an introduction to nuclear physics. New York, Interscience Publishers, Inc., 1946; Gordy, Phys. Rev. 76, 139(1949)). A simple model is proposed, based on nuclear shell considerations, which leads to a proper behavior of

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known quadrupole moments although predictions of the magnitudes are sometimes badly in error. Conclusions drawn from this model are compared with a plot of quadrupole moments as a function of the number of nucleons. It appears that Gordy's work is in error. Failure of the shell model to give correct quadrupole moments seems to indicate a failure of the single particle field quantization method.

771 Nuclear Specific Heats of Copper Salts. R. J. Benzie and A. H. Cooke. Nature 164, 837(1949) Nov. 12 (Letter to the editor).

The magnetic susceptibilities and specific heats of copper ammonium sulfate, copper rubidium sulfate, and copper cesium sulfate and of the same salts diluted with the corresponding zinc salts have been measured in order to investigate Gorter's suggestion (Physica 14, 504(1948)) that in salts containing ions which possess both an electronic and a nuclear magnetic moment, the coupling of the moments will be sufficient to permit the alignment of the nuclear moments in a magnetic field of a few hundred gauss at temperatures of the order of 0.01°K. A further effect of this coupling will be a nuclear contribution to the specific heats of paramagnetic salts having ions which possess a nuclear moment, e.g., salts of cobalt, manganese, or copper. Measurements have been made in the temperature range 1.0-4.2°K, in fields of 100-200 gauss, by the paramagnetic relaxation method (Casimir et al, Physica 8, 449(1941)), which measures the specific heat of the magnetic ions, excluding the salt's lattice specific heat. A curve is shown of the specific heat constant CT^2/R for a fixed mass of the copper salt as a function of the molar concentration of the copper salt. At zero concentration the specific heat constant is $(1.1 \pm 0.05) \times 10^{-4}$. The measurements on the other salts are less complete, but are consistent with the same or possibly a slightly higher value. An approximate calculation gives values of the specific heat constant due to dipole interaction of between 1.3×10^{-4} (ammonium salt) and 1.2×10^{-4} (cesium salt). The contributions due to exchange are then 6.3×10^{-4} for copper ammonium sulfate, 3.6×10^{-4} for copper potassium sulfate, 0.9×10^{-4} for copper rubidium sulfate, and 0.35×10^{-4} for copper cesium sulfate.

772 The Nuclear Spin of He^3, A. E. Douglas and G. Herzberg. Phys. Rev. 76, 1529(1949) Nov. 15 (Letter to the editor).

The spin of the He^3 nucleus has been determined from the intensity alternations in the band spectrum of the He^3 molecule. The photometer curve for the band at 6400 A is reproduced and it is seen that the intensity ratio of adjacent lines is approximately 3:1. It is definitely established that the spin is 1/2 and that the nucleus obeys Fermi statistics. The He^3 was excited in a Geissler tube and the spectrum taken with a 21-ft grating.

773 Observation of the Nuclear Magnetic Resonance in a Super-Reactive Receiver. Pierre Grivet and Michel Soutif. Compt. rend. 228, 1852-4(1949) June 13 (in French).

The observation of nuclear magnetic resonance in the proton has been made by means of a super-reactive receiver as

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suggested by Roberts (Rev. Sci. Instruments 18, 845(1947)). The receiver and electromagnet used are described. The proton was studied in pure water, in paramagnetic solutions of varying concentrations and in the solids NH_4Cl and NH_4F, at frequencies in the 20-30 Mc range. Confirmation of the theory (Bloembergen et al, Phys. Rev. 73, 679(1946)) was obtained in the width of the lines for the solids and liquids.

774 On the Autodyne Method in Nuclear Magnetic Resonance. Pierre Grivet, Michel Soutif, and Robert Gabillard. Compt. rend. 229, 27-9(1949) July 4 (in French).

A method is described which has been used to observe nuclear magnetic resonance by means of the small periodic variation in the inductance ΔL and apparent resistance Δr of a small coil at high frequencies. It had been suggested by Gorter that the coil and a condenser be used to obtain an oscillating circuit for an auto-oscillator. It was found that the apparatus is more sensitive to variations in ΔL (dispersion) than to the variations in Δr (absorption), which were only observable at very feeble oscillation intensities. Saturation of the dispersion effect was observed, also, but for excitations so large that the absorption effect had completely disappeared. A curve is given for the variation of the dispersion intensity as a function of the degree of ionization for distilled water and normal and saturated aqueous solutions of ferric nitrate. Information obtained from the oscillograph of the resonance is discussed which gives evidence of some new aspects of the phenomenon.

775 On the Interaction of Nuclear Spins in a Crystalline Lattice. N. Bloembergen. Physica 15, 386-426(1949) May.

The exchange of energy between a system of nuclear spins immersed in a strong magnetic field, H_0, and the lattice vibrations of insulating crystals has been investigated experimentally by the method of nuclear magnetic resonance absorption. The resonance in calcium fluoride and in several hydrated sulphates and alkali halides has been observed between 300 and 1°K at 30.5 and 9.5 Mc/sec. The measured spin-lattice relaxation times range from 10^{-3} to 10^{4} sec and markedly disagree (in many cases by a factor of 10^{6}) with the values given by Waller's theory of paramagnetic relaxation (Z. Physik 79, 370(1932)). It is shown that the relaxation time is determined by paramagnetic impurities occurring in the lattice. An "order of magnitude" theory is developed taking this into account. The quanta absorbed by the system of nuclear spins from the external radiofrequency field diffuse toward the impurities. The energy is then transferred to the lattice (from the impurity) via the fluctuating magnetic field. The first process depends on the concentration of the impurities, the second on the magnitude of H_0 and on the relaxation times of the impurity. This affords a qualitative explanation of the experimental data. In some cases a direct heat contact between the system of nuclear spins and the system of impurity spins proved important; in such cases the spin-lattice relaxation time is independent of the lattice temperature. 31 references.

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776 On the Lowest Excited States of Atom Nuclei. Peter Preiswerk. Helv. Phys. Acta 22, 372-5(1949) Aug. (in German).

Upon the assumption that the rotation of the nucleus as a whole can be regarded as a source of its excited states, energy levels were calculated for various J, as a function of the atomic number; as a first approximation, the hypothesis of a rigid symmetrical rotator was adopted. A number of γ lines of various elements could thus be accounted for, J being equal to 0, 1, 2, 3. In this, the present attempt differs from that of Guggenheimer (Proc. Roy. Soc. 181, 169(1943)) who assumed the existence of much lower levels than those actually observed.

777 On the Spatial Alignment of Nuclei. R. V. Pound. Phys. Rev. 76, 1410-11(1949) Nov. 1 (Letter to the editor).

The degeneracy due to the $2I + 1$ possible nuclear spin orientations may be partially lifted through the interaction between the nuclear electric quadrupole moment and a crystalline electric field having axial symmetry. So far only moderate quadrupole splittings have been found, but much larger splittings should exist in crystals composed of molecules having p-type covalent bonds. It is proposed that this splitting may be used for the partial spatial alignment of nuclear spins, by cooling the crystal to a few hundredths of a degree Kelvin. Magnetic resonance methods for observing this splitting are briefly discussed.

778 On the Theory of Particles with the Spin Two. M. Ya. Shirobokov. Zhur. Eksptl. i Teoret. Fiz. 19, 481-6 (1949) (in Russian).

The author has shown (Zhur. Eksptl. i Teoret. Fiz. 19, 481-6(1949)) that the effective cross section for light scattering of particles with the spin 2 increases indefinitely and very rapidly with the energy of the light quanta; he concluded that such a particle's electromagnetic moments are of a higher order than that of a dipole. He shows in the present note that a particle with a spin 2 possesses, not a kinematic dipole electromagnetic moment, but a radiation-active quadrupole, and an octupole, moments that do not vanish in the extreme relativistic case.

779 The Paschen-Back Effect in NH_3 and N_2O Microwave Spectra. C. K. Jen. Phys. Rev. 76, 1494-1501(1949) Nov. 15.

The Paschen-Back effect in the microwave spectra of NH_3 and N_2O has been investigated with a resonant cavity spectroscope. The results for $N^{14}H_3$, representing a case of one-nuclear (N^{14}) coupling, show the effects of gradual decoupling of the nuclear spin from molecular rotation. The existence of the "forbidden" lines, whose intensities diminish with increasing field, indicates that the decoupling is not quite complete even in a field of 10,000 oersteds. The results for $N^{14}N^{14}O^{16}$, representing a case of two-nuclear (N^{14},N^{14}) coupling, show that the decoupling is almost complete at a field of 10,000 oersteds. An asymmetry of the Paschen-Back pattern for a $\Delta J \neq 0$ transition is ascribed to the nonlinear dependence of

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the nuclear quadrupole coupling energy upon M_J and M_I. The measured results are found to be in good agreement with quantum mechanical calculations. Also, consistent with the theory of the structure of the Paschen-Back pattern, it is shown that the molecular g-factors and the nuclear quadrupole coupling factors can be determined directly from experimental data.

780 The Shell Structure of Atomic Nuclei. Erich Bagge. Naturwissenschaften 35, 375(1949) (Brief note, in German).

According to Mayer nuclei with 50, 82, and 126 neutrons are especially stable. The author points out that these numbers can be considered as given by the equation

$$N(n) = \frac{n^3 + 5n}{3}$$

letting n = 5, 6, 7, and that this equation can furthermore be generalized to

$$N(n) = 2 \sum_{m=1}^{n} \left(1 + \binom{m}{2}\right),$$

This would indicate that nuclear energy levels are characterized by two quantum numbers, m and n, and provides a scheme according to which the closed and extremely stable nucleon shells are built up.

781 A Simplified High Frequency Bridge for the Observation of Nuclear Magnetic Resonance. Pierre Grivet, Michel Soutif, and Maurice Buyle. Compt. rend. 229, 113-15(1949) July 11 (in French).

The precision necessary to obtain meaningful data using the method of Purcell and Pound (Phys. Rev. 73, 679(1948)) is noted, as is the fact that such precision necessitates a fine equilibrium of a high frequency bridge and a rigorous protection of all the parts of the bridge against external disturbances. An improved circuit for this purpose is shown which has a low impedance and makes use of resonance in a series circuit, in place of the usual parallel combination. A modified circuit is also shown for use at high frequencies.

782 Tables of Oscillator Strengths and of Transition Probabilities in Atoms with a Small Number of Electrons. M. G. Veselov. Zhur. Eksptl. i Teoret. Fiz. 19, 959-64(1949) (in Russian).

Using values of wave functions of light atoms, given by various writers, e.g., by Morse et al (Phys. Rev. 48, 948(1935)), the author calculated oscillator strengths and probabilities of one-electron transitions of the types 2p − 1s and 2p − 2s, in atoms and ions possessing two, three, and four electrons. The results are presented in tables giving the matrix elements, energy differences, oscillator strengths, transition probabilities, and half-life periods of stationary states, for H, He, Li, Be, B, C, and Ne, and their one-, two-, three-, and four-electron ions. The exactitude of the relative values that can be derived from the data is much greater than that of the absolute values themselves.

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783 Transient Nutations in Nuclear Magnetic Resonance. H. C. Torrey. Phys. Rev. 76, 1059-68(1949) Oct 15.

Transient nutations of the resultant nuclear magnetic moment vector are set up by applying radiofrequency power in the form of pulses in the neighborhood of resonance ($\omega = \gamma H_0$). The nutations have an initial amplitude depending on the state of magnetization at the start of a pulse and on the proximity to resonance, and are damped by spin-spin and spin-lattice interaction. The thermal relation time can be directly found by observing the dependence of initial amplitude on the time between pulses. The spin-spin time constant T_2 can be found from the rate of decay even in the presence of normally disturbing inhomogeneity in the magnetic field. Sensitivity is in many cases comparable to that obtained in the modulation method with narrow band amplifiers. The fast response due to the relatively wide band widths used can be applied to a rapid search for unknown resonances. The effects observed are in qualitative accord with predictions based on the Bloch theory (Phys. Rev. 70, 460(1946)).

784 The Aspatron; Conflicting Views on Simplified Irradiation. Anonymous. Chem. Age 61, 697-8(1949) Nov. 19.

A new apparatus, the Aspatron, which is a simplified device for the production of artificially radioactive material is described. The outstanding characteristic of the Aspatron, contrasting with all other atomic energy assemblies, is its extreme simplicity. It resembles a large tea-urn and its mechanical make-up is almost as simple: primarily an outer canister of high purity burnished copper, within which is an inner lining, also of highly refined copper. Water, as a moderator, is contained between the two, within a wall space of about 2 in. Ten circular trays, each pierced in the center, are placed on top of each other in the water-jacketed vessel, leaving a central funnel of about 2 in. diameter. This space accommodates a boron-steel "arrestor rod" which maintains the "pile" in a state of quiescence; in operation, a capsule containing material to be irradiated is placed in the tube. The trays are filled and arranged to hold alternately paraffin wax, serving as a moderator, and uranium oxide. The Aspatron is primarily intended for use as a source of neutrons in localities where orthodox piles or cyclotrons are not available.

785 The Atomic Rocket Motor. Part III. M. G. Whybra. Rocketscience 3-4 qtly., 88-91(1949) Dec.

Presented is a discussion of the nuclear-physical aspects of the reactor of an atomic rocket motor. Factors influencing reactor design are reactor-weight to thrust-weight ratio, critical size, material cross sections, and the average logarithmic energy loss. These factors are next considered in relation to the fast reactor where the neutrons lose very little of their energy before encountering a fissile nucleus and the thermal reactor where the neutron loses almost all of its initial energy in a few collisions and soon gains thermal equilibrium with the medium. With a suitable working fluid passing through a solid reactor at about 3500°K and then exhausting through a nozzle, we may expect to attain exhaust velocities of 2×10^4 to 3×10^4 ft/sec, thus permitting a single-stage rocket to escape the gravitational field of the earth.

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786 The First Pile. Corbin Allardice and Edward R. Trapnell. TID-292, Nov. 17, 1949. 13p.

This report is a narrative history of the first self-sustaining nuclear chain reaction, successfully completed at Chicago University on December 2, 1942. The story was compiled from the personal recollections of more than a dozen of the 42 scientists present at the experiment.

787 The French Nuclear Reactor. Metal Prog. 56, No. 9, 202-3(1949) Aug.

This is a very brief account of the French atomic energy program. Accompanying the article is a diagram of a French 10-kw reactor and a discussion on the reason for the use of such a reactor.

788 Fission Excitation Functions for Charged Particles. J. Jungerman. AECD-2744, Sept. 21, 1949, Decl. Nov. 22, 1949. 24p.

The detection of fission produced by means of bombardment with charged particles has been accomplished using a method which consisted of counting the pulses of ionization produced by the fission fragments in an ionization chamber. The detection of a fission pulse in the presence of the ionization produced by the beam itself is made possible by using a cancellation principle (G. C. Baldwin and G. S. Klaiber, Phys. Rev. 71, 3(1947)). This principle has been used to measure fission excitation functions on the 60-in. Crocker cyclotron and the 184-in. synchrocyclotron.

60-in. cyclotron. The excitation functions for U^{238}, Th^{232} and U^{235} bombarded with alpha particles and deuterons, respectively, have been plotted as Mev's vs cross section in barns. The value of w, the average number of electron volts necessary to form an ion pair, was determined and the results tabulated. These values were used to find the multiplication factor, M, introduced by the ionization chamber when the computation of the fission cross sections was made. In order to have an independent check on the absolute value of the cross section the cross section of the reaction $Bi^{209}(\alpha,2n)At^{211}$ was measured with the same equipment. Comparison of the results obtained with a previous experiment (J. Jungerman and S. C. Wright, Phys. Rev. 74, 150(1948)) were made. A comparison of fission cross sections and calculated total reaction cross sections for alpha particles of a thorium target indicated that competition is greatest in the case of the thorium and least for U^{235}.

184-in. synchrocyclotron. Excitation functions were observed and plotted for alpha particle and deuteron bombardment of U^{238}, Th^{232}, U^{235}, Bi^{209}, and Au^{197}. Results are similarly evaluated and discussed.

789 Comments on Photo Fission Threshold Measurements. Katharine Way. AECD-2752, nd, Decl. Dec. 5, 1949. 4p.

Photo-fission threshold measurements for Th^{232}, U^{233}, U^{235}, U^{238}, and Pu^{239}, by Koch et al (AECD-2699) are discussed. The values seem to lack sufficient variation from one target nucleus to another, contrary to predictions of the liquid drop model (Bohr and Wheeler, Phys. Rev. 56, 426(1939)). Assumptions are made, however, which make the values consistent with known β and α decay energies.

790 The Production of Li^8 from Various Gases. S. Courtenay Wright. AECU-588(UCRL-467), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Li^8 has been produced by 340-Mev proton and 190-Mev deuteron bombardment of C, N, Ne, A, Kr, and Xe. The target element formed the gas of a proportional counter. The 0.88-sec beta decay of Li^8 produced Be^{8*} which disintegrated into two alpha particles with a half-life of 10^{-21} sec. Li^8 was detected by observation of these alpha particles and identified by its half-life. Deuteron excitation functions for the production of Li^8 are given for C, N, Ne, and A. In the case of 190-Mev deuterons the cross section varies from about 10^{-27} cm^2 for C to 2×10^{-29} cm^2 for Xe. For 340-Mev protons the variation is from about 7×10^{-27} cm^2 for C to 3×10^{-29} cm^2 for Xe. A discussion of the process involved is given.

791 Nuclear Fission and Radiochemical Research Associated with Nuclear Reactors; Chemistry Conference No. 3. AECU-645(BNL-C-9), July 14-15, 1949. 18p.

At this third of a series of Brookhaven National Laboratory chemistry conferences the following papers were presented: Present Status of the Theory of Fission, by G. C. Wick; High Energy Induced Fission of Bismuth and Lead, by R. H. Goeckermann and I. Perlman; Current Radiochemical Research at Los Alamos, by R. W. Spence; Radiochemical Studies of Short-Lived Activities, by N. Sugarman; Radiochemistry at Chalk River, by L. Yaffe; A Summary of Nuclear Chemistry Work at Argonne, by M. H. Studier; Slow Neutron Reactions, by M. Goldhaver; Technetium Isotopes and Technetium Chemistry, by G. E. Boyd; Some Recent Nuclear Studies at Oak Ridge National Laboratory, by B. H. Ketelle; Assignment of Activities of the Tin Isotopes, by C. M. Nelson. References included.

792 Absolute Voltage Determination of Two Nuclear Resonances Below 0.4 Mev. A. H. Morrish. Phys. Rev. 76, 1651-7(1949) Dec. 1.

An absolute voltage determination was made of the $F^{19}(p\alpha',\gamma)$ and the $B^{11}(p,\alpha)$ and $B^{11}(p,\gamma)$ resonances. A calibrated electrostatic analyzer was used to measure the proton beam energy from a Crockroft-Walton linear accelerator. The values obtained were 0.3404 ± 0.0004 Mev and 0.1628 ± 0.0002 Mev, respectively. An approximate estimate of the half-width appears to give 2.0 ± 1.0 kv for the fluorine and 4.5 ± 1.5 kv for the boron resonance.

793 Angular Distribution of the Protons Produced by Boron Bombarded by Deuterons, and Study of the Proton-Gamma Ray and Alpha-Gamma Ray Coincidences in the Disintegration of Boron by Deuterons. Jacques Thirion. Compt. rend. 229, 1007-9(1949) Nov. 14 (in French).

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Six-hundred kev deuterons, bombarding a boron target, produce the reaction $B^{10}(dp)B^{11}$. The resulting energy groups of protons were detected with a proportional counter and amplifier, sensitive only to the large pulses produced by the protons at the end of their paths. Absorption measurements were taken in the direction of the bombarding beam and at right angles to the beam. The different energy groups produced peaks in the counting rate for different absorption thicknesses, and differences appeared in the relative intensity of these peaks at the two angles. Data is given on coincidence measurements. No alpha-gamma coincidences were found, in agreement with postulated decay schemes.

794 Angular Distribution of Protons in Reactions $O^{16}(d,p)O^{17}$ and $Al^{27}(d,p)Al^{28}$. Yu. A. Nemilov and B. L. Funshteĭn. Doklady Akad. Nauk S.S.S.R. 66, 609-12(1949)(in Russian).

Angular distributions of protons from (d,p) reactions were determined with the aid of a wedge filter, circularly bent and provided with a photographic film on the outside; the target was in the center. The darkening of the film was measured microphotometrically; a many-step curve was obtained, the steps corresponding to protons of definite energy. In the reaction $O^{16}(d,p)O^{17}$ the target was a 0.5μ gold foil on which a layer of tungsten oxide was precipitated; the energy of bombarding deuterons was 2.6 and 3.9 Mev. Two groups of protons were observed, corresponding to the formation of the O^{17} nucleus in the ground state and in the first excited state; the corresponding reaction energies, determined from the proton ranges, were 1.9 and 1.0 Mev; a well marked angular distribution effect was observed, the protons being projected predominantly in the forward direction, coinciding with that of the impinging deuterons; the effect is more pronounced with the lower energy protons. For the reaction $Al^{27}(d,p)Al^{28}$the target used was an Al foil of 1.1 cm air equivalent; the deuteron energy was 3.9 Mev. Five groups of protons were observed, the corresponding reaction energies being 5.5, 4.4, 3.0, 1.8 and 0.3 Mev; the same directional effect, as in the O case, was observed here for the three lower energy groups. These results, while disagreeing with those obtained by Heydenburg et al (Phys. Rev. 73, 230(1948)), seem to confirm the ideas of Serber (Phys. Rev. 72, 1008(1947)) and Peaslee (Phys. Rev. 74, 1001(1948)), who consider the (d,p) process as a tearing away of a neutron from a passing deuteron under the action of a nuclear field.

795 $B^{10}(n,\alpha)Li^7$ Reaction with Slow Neutrons. A. Stebler, P. Huber, and H. Bichsel. Helv. Phys. Acta 22, 362-4 (1949) Aug. (in German).

The bombardment of B^{10} with slow neutrons results in the emission of α particles and the formation of Li^7(8%) and Li^{7*}(92%). The authors determined the reaction energies Q and Q^* with the aid of the ionization chamber and pulse-spectrograph described in Helv. Phys. Acta 21, 59(1948). The ionization chamber was filled with a mixture of BF_3 with O_2, N_2, or A. With the pulse-spectrograph, curves were obtained photographically that gave the relative intensities and positions of maxima corresponding to the various reaction products. The results depend on the nature of the gas admixed to BF_3: with O_2 $Q = 2.68 \pm 0.02$, $Q^* = 2.19 \pm 0.02$; with N_2, $Q = 2.68 \pm 0.02$, $Q^* = 2.19 \pm 0.02$; with A, $Q = 2.73 \pm 0.02$, $Q^* = 2.24 \pm 0.02$.

796 Cross Section for Fission of U^{238} by Means of the Lithium Gamma Radiation ($h\nu$ = 17.5 Mev). G. Charbonnier, P. Scherrer, and H. Wäffler. Helv. Phys. Acta 22, 385-6(1949)(in German).

The cross section for photo-fission of the U^{238} nucleus was determined by the photographic method. Kodak NTA type plates were saturated in a solution of high uranium concentration. The emulsions thus treated contained 2.8×10^{18} U-nuclei/cm^2 of surface area. They were then bombarded for several hours with lithium γ rays. Using a value of the absolute intensity of the lithium γ radiation given elsewhere (Waeffler and Hirzel, Helv. Phys. Acta 21, 200(1948)) the cross section was found to be $4.6 \pm 1.5 \times 10^{-26}$ cm^2. This is in good agreement with the results of Baldwin and Klaiber (Phys. Rev. 71, 3(1947)), who used the bremsstrahlung of a 100 Mev betatron, but is three times as great as the value found by Arakatsu (Proc. Phys.-Math. Soc. Japan 23, 440 (1941)) who also used lithium γ rays.

797 Disintegration of Deuterons by Collisions with Electrons. W. Paul. Naturwissenschaften 36, 31-2(1949) (Brief note, in German).

Electrons accelerated up to 5 Mev were used to bombard deuterons. The observed neutron yield is interpreted as due to a superposition of a (γ,n) and an (e,n) process, both of which have approximately the same cross section. The cross section for (ϵ,n) was determined as $10^{-31} - 10^{-30}$ cm^2.

798 (γ,α)-Reaction of C^{12} and the Alpha Particle Model of light Nuclei. V. L. Telegdi and M. Verde. Helv. Phys. Acta 22, 380-5(1949)(in German).

The photo-effect calculated by means of the wave functions of an α-particle model gives a qualitatively satisfactory description of the reaction $C^{12}(\gamma,\alpha)Be^{8*}$. The authors are of the opinion that because of the preliminary character of the experimental results concerning this reaction it is not yet possible to achieve exact quantitative agreement, using more complicated wave functions. Therefore, a decision between the α-particle model and the compound nucleus cannot yet be made for this case.

799 Investigations of the Capture of Protons and Deuterons by Deuterons. W. A. Fowler, C. C. Lauritsen, and A. V. Tollestrup. Phys. Rev. 76, 1767-8(1949) Dec. 15.

The capture of protons and deuterons by deuterons has been studied up to energies of 1.5 Mev. An upper limit of $\sim 10^{-31}$ cm^2 has been found for the D(d,γ) reaction near 1 Mev. The γ radiation from D(p,γ) has been found to have an angular distribution obeying a $\sin^2\theta$ law. The cross section of the reaction is given empirically from 0.5 to 1.5 Mev by $\sigma = 0.74E^{0.72} \times 10^{-29}$ cm^2 for E in Mev.

800 Investigation on the Energy of Protons Emitted During the Bombardment of Aluminum and Silicon

by Deuterons. Yu A. Nemilov. Doklady Akad. Nauk S.S.S.R. 66, 369-71(1949) May 21 (in Russian).
The energy spectrum of protons, freed by irradiating aluminum and silicon with 3.9-Mev deuterons, was determined with the aid of a wedge filter, by measuring the variously darkened zones on a photographic plate (see preceding work on Mg, Doklady Akad. Nauk. S.S.S.R. 63, 115(1948)). The Al target was a foil equivalent to 1.1 cm air. The silicon target was either a 5μ quartz membrane, or a precipitate of Si from a suspension in a mixture of ether and acetone. The experiments with Al revealed five groups of protons corresponding to reaction energies 5.47 ± 0.15, 4.37 ± 0.15, 3.05 ± 0.10, 1.78 ± 0.10 and 0.28 ± 0.10 Mev with the corresponding relative intensities 1, 1.5, 3, 3.5, 7. Since there exists only one stable isotope of Al, viz. Al^{27}, the only possible reaction is Al^{27} (d,p) Al^{28}, and the above given values correspond to the ground level and four excited states of Al^{28}. The measurements with the Si targets showed five groups of protons corresponding to reaction energies 6.12 ± 0.15, 4.95 ± 0.15, 4.05 ± 0.15, 2.49 ± 0.15 and 1.24 ± 0.10 Mev; the intensities could not be determined. In the author's opinion, the preponderating reaction is that involving the most abundant isotope Si^{28}, viz. $Si^{28}(d,p)Si^{29}$, so that the above values correspond to the ground state and four excited states of Si^{29}.

801 Magnetic Analysis of $Be^9(d,\alpha)Li^7$ and $Be^9(d,p)Be^{10}$ Reactions. W. W. Buechner and E. N. Strait. Phys. Rev. 76, 1547-9(1949) Dec. 1.
The α particle and proton groups arising from the deuteron bombardment of beryllium targets have been studied with a high resolution magnetic spectrometer. Except for the well-known one at 480 kev, no evidence has been found for energy levels in Li^7 between 3.4 Mev and the ground state. The Q-value for the $Be^9(d,\alpha)Li^7$ reaction has been measured as 7.145 ± 0.024 Mev. Studies of the proton groups indicate that there are no levels in Be^{10} between the ground state and one at 3.375 ± 0.010 Mev. The Q for the $Be^9(d,p)Be^{10}$ reaction has been found to be 4.576 ± 0.012 Mev.

802 Magnetic Analysis of the $C^{12}(d,p)C^{13}$ and $O^{16}(d,p)O^{17}$ Reactions. W. W. Buechner, E. N. Strait, A. Sperduto, and R. Malm. Phys. Rev. 76, 1543-6(1949) Dec. 1.
The proton groups that result from the deuteron bombardment of C^{12} and O^{16} tragets have been analyzed with a high resolution magnetic spectrometer. For the $C^{12}(d,p)C^{13}$, 13^* reactions, the Q-values have been measured as 2.729 ± 0.009 and −0.370 ± 0.003 Mev. No evidence has been found for energy levels of lower energy than the one which is thus determined to be at 3.098 ± 0.008. The reaction energies for the two proton groups observed to come from $O^{16}(d,p)O^{17}$ are 1.925 ± 0.008 and 1.049 ± 0.007 Mev, with 0.876 ± 0.009 Mev as the energy of the first excited state in O^{17}.

803 Magnetic Analysis of the $Li^6(d,p)Li^7$ and $Li^7(d,p)Li^8$ Reactions. E. N. Strait and W. W. Buechner. Phys. Rev. 76, 1766-7(1949) Dec. 15.
The energy release of the $Li^6(d,p)Li^7$ reaction has been measured as 5.006 ± 0.014 Mev, using a semicircular magnetic analyzer. The hitherto unobserved protons from the $Li^7(d,p)Li^8$ reaction have been found and their energy measured. The Q for this reaction has been determined as −0.193 ± 0.008 Mev.

804 The Photo-Disintegration of the Deuteron. Ingvar F. E. Hansson and Lamek Hulthén. Phys. Rev. 76, 1163-5(1949) Oct. 15.
The photomagnetic and photoelectric cross sections have been calculated for γ energies 2.62, 2.76, and 6.2 Mev, using different values of the deuteron binding energy (2.19 and 2.24 Mev). The calculations were carried out for a symmetrical theory with meson potential (Møller-Rosenfeld theory), the corresponding neutral theory (ordinary force) and a third version with no ^3P interaction. Non-central forces were neglected. Results are given for two ranges, equivalent to meson masses 200 and 300. The influence of the γ-ray momentum on the angular distribution of the photonucleons should be noted.

805 Photo-Fission of Uranium with Possible Emission of a Beryllium Nucleus. F. K. Goward, E. W. Titterton, and J. J. Wilkins. Nature 164, 661-2(1949) Oct. 15 (Letter to the editor).
A photographic plate is shown as evidence for the presence of energetic heavy fragments in the ternary photo-fission of uranium. The disintegration was observed in a uranium-loaded Ilford emulsion type D_1 irradiated with 23-Mev γ rays. Superficially, the disintegration appears to be a quaternary fission with the emission of two α particles of energies 9.5 and 10.5 Mev, respectively, and inclined at 7 deg. to each other. A second possibility is, however, that the event represents the emission of a Be^8 nucleus with an energy of 20.0 ± 0.5 Mev, which immediately disintegrates into two α particles, the angle of emission of the Be^8 nucleus relative to the light fission fragment being 74 deg. Only one event of this kind has been observed in a study of some 10,000 photo-fissions.

806 Protons from the Bombardment of He^3 by Deuterons. L. D. Wyly, V. L. Sailor, and D. G. Ott. Phys. Rev. 76, 1532-3(1949) Nov. 15 (Letter to the editor).
A study of $He^3(d,p)He^4$ has been made at Yale University using a 1.13-cm^3 sample of helium gas containing 88% He^3 and 12% He^4. The objectives of this study were to determine the angular distribution of the proton yield, to search for excited states of the He^4 nucleus at several angles, and to determine experimental Q-values for the reaction by measuring the ranges of the emitted protons. Comparison of the experimental Q-value with the calculated Q-value gives an experimental point on the range-energy curve for high energy protons. The helium was bombarded with a deuteron beam and the protons detected by a proportional counter making various angles with the beam. The ranges, energies, and Q-values found are tabulated and the results are in good agreement with the range-energy curve of Bethe. No excited states of He^5 were observed.

807 The Radioactive Isotopes of Phosphorus. B. G. Dzantiev and A. M. Neiman. Uspekhi Fiz. Nauk 38, No. 3, 338-73(1949)(in Russian).

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The following topics are discussed in this article: (1) the isotope P^{32}, (2) its separation from the carbon bisulfide target, (3) the dependence of the yield of P^{32} upon the energy of the neutrons, (4) the period of decomposition of P^{32}, (5) the isotope P^{30}, (6) the dependence of the yield of P^{30} upon the energy of the α-particles, (7) extraction of a stable isotope of P^{30}, (8) the period of semi-decomposition of P^{30}, and (9) the isotope P^{34}.

808 The Reality of Neutrinos. George Gamow. Phys. Today 1, 4-7, 30-1(1948) July.

The role of the neutrino in nuclear transformations is considered and investigations designed to give evidence of the existence of the neutrino are reviewed. The following topics are treated: neutrino-recoil experiments, K-capture experiments, the mass of the neutrino, absorption and scattering of neutrinos, urca processes, and the physical nature of the neutrino. The author describes urca processes as occurring at high temperatures and resulting in the traceless disappearance of energy as neutrinos and antineutrinos. The possible role of such processes in cosmical processes is noted.

809 Relative Cross Sections for Pair Production at 17.6 Mev. R. L. Walker. Phys. Rev. 76, 1440-4(1949) Nov. 15.

The relative cross sections for production of electron pairs by 17.6-Mev γ rays have been measured for Li, C, Al, Cu, Sn, and Pb. A γ-ray pair spectrometer was used to count the number of pairs emitted from thin radiators of these materials when irradiated by 17.6-Mev γ rays. For each material, the number of pairs counted per atom of radiator has been extrapolated to a radiator of zero thickness, in order to obtain the relative pair cross section. From these measurements some information can be obtained about the probability of pair production in the field of the atomic electrons, and about the errors in the theoretical pair cross sections of heavy elements. It is found that the ratio of the pair cross section of an electron to that of a nucleus of unit charge is 0.8 ± 0.3. The data indicate that the pair cross sections of heavier elements are lower than predicted by the Born approximation, in qualitative agreement with measurements of the total absorption cross sections.

810 A Schematic Theory of Nuclear Cross Sections. H. Feshbach and V. F. Weisskopf. Phys. Rev. 76, 1550-60 (1949) Dec. 1.

In this paper a description of the energy dependence of nuclear cross sections, especially for neutrons, is given in terms of simple assumptions on the properties of the nuclei. The results are supposed to represent average values over individual fluctuations and resonances. The total cross section, the reaction cross section, and the transport cross section are calculated as functions of the neutron energy. Only two nuclear parameters occur in the expressions; the nuclear radius and the average kinetic energy of a nucleon inside the nucleus. Comparison of the theory with neutron experiments is made. New values of nuclear radii are computed from total cross sections at 14 and 25 Mev. Predictions of the inelastic cross sections at 14 Mev are in good agreement

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with the measurements. Experiments involving total and transport cross sections between 0.1 and 1.5 Mev are compared with theory and reasonably good agreement is found with most of these. However, for the elements, I, In, and Sb, agreement in the context of the theory may be obtained only if the strength of resonance levels for these elements is assumed to be unusually low.

811 The Theoretical Cross Section of the Photodisintegration of the Deuteron. I. Halpern and W. M. Woodward. Apr. 15, 1949. 15p. (NP-1075).

In the course of an experiment on the angular distribution of the photodisintegration of the deuteron recently performed at the High Voltage Laboratory at the Massachusetts Institute of Technology, it was found desirable to recalculate the theoretically expected angular distributions on the basis of the most recent information about the neutron-proton forces. With very little extra work, these same calculations gave the total deuteron photodisintegration cross section as a function of energy and the cross section for the capture of slow neutrons by hydrogen. These calculations have been assembled in this report. The results of the calculations seem to agree fairly closely with experiment. The theoretical capture cross section in hydrogen and the photomagnetic disintegration cross section of the deuteron may possibly be a little too low; but, with the relatively large uncertainties in the experimental data so far available, it is not possible to draw definite conclusions. 17 references.

812 A Device for Determining the Direction of Flux Lines in the Time Varying Magnetic Field of a Particle Accelerator. Robert E. Richardson and Duane C. Sewell. AECU-656(UCRL-488), Oct. 25, 1949. 6p.

The stable particles in the beam of an accelerator such as the synchrotron oscillate about a surface which is near the median plane of the magnet gap. The position of this surface can be determined if the direction of the magnetic flux lines near the median plane of the gap is known and if the variation of the magnetic field with radius in the median plane is known. The flux lines are vertical near the median plane of the gap in a magnet with the usual horizontal gap; these lines are vertical at the median plane in the ideal case. This paper describes a device for determining in a time varying magnetic field the position where the magnetic flux lines are vertical. The method is a null method. A coil is suspended vertically in the magnet gap with the axis of the coil horizontal and perpendicular to the beam path. The magnet is pulsed with the coil at various vertical positions in the gap. The voltage induced in the coil, which is proportional to the rate of change of net horizontal flux through the coil, is viewed on a cathode ray oscilloscope. When the center of the coil is at a point where the flux lines are vertical, there is no net horizontal flux linking it, and the induced voltage is zero. If the coil is above this point there will be a voltage induced, and if the coil is below the point a voltage of opposite polarity will be observed.

813 Betatrons With and Without Iron Yoke. A. Bierman and H. A. Oele. Philips Tech. Rev. 65-78(1949) Sept.

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An article similar in content appeared in Nature 163, 649-650(1949) Apr. 23. An abstract of this article appeared in Nuclear Science Abstracts as abstract No. 3-411.

814 The Effects of Pressure on the Thermal Diffusion Ratio. H. G. Drickamer and J. R. Hofto. J. Chem. Phys. 17, 1165(1949) Nov. (Letter to the editor).

According to the theory of Enskog and Chapman (Chapman and Cowling, The Mathematical Theory of Non-Uniform Gases. London, Cambridge University Press, 1939) the thermal diffusion ratio should be independent of pressure at ordinary pressures. Data obtained by Grew (Nature 156, 267 (1945)) indicates that this is true for CO_2-H_2. Experiments were carried out on CO_2-C_3H_8 at pressures from 0.3 to 1.8 atm and the results are tabulated. It appears that, at low pressures, and at temperatures well above the critical point, α is independent of pressure, but this may not be true at lower temperatures. Experiments are being carried out near the critical point.

815 Meeting of the Physical Society of Rheinland-Pfalz (Germany), held at Mainz on May 14, 1949. Physik. Blatter 5, 380-3(1949)(in German).

The following papers, amongst others, were presented: Physical Processes in Diffusion- and Vapor-Ray-Pumps, R. Jaeckel. Methods of Measurement in High Vacuum Technique, H. Klumb. Starting Points of a Non-Linear Form of Electrodynamics, K. Bechert. On the Possibility of the Production of Directed Mutations in Organisms, K. Bechert. Results of a Quantum Theoretical Investigation of Satellite Trajectories, H. A. Schwab.

816 On the Thermomechanism of Diffusion. J. E. Verschaffelt. Bull. classe sci., Acad. roy. Belg. 35, 293-310(1949)(in French).

The author extends previous work dealing with the thermomechanical properties of fluids in motion (Bull. classe sci., Acad. roy. Belg. 28, 476-489(1942); ibid, 34, 344-355(1948)) and the theory of thermal diffusion (Wis- Natuurk. Tijdschr. 11, 49-72(1942); Bull. classe sci., Acad. roy. Belg. 34, 126-151(1948)). The equations of thermal diffusion are developed from the general point of view of the thermodynamics of irreversible phenomena, with special regard to the principles of reciprocity and of superposition.

817 Proceedings of the Americal Physical Society. Meeting held on Dec. 29-30, 1949, at Stanford. Bull. Am. Phys. Soc. 24, 3-18(1949) Dec.

Among the papers presented at this meeting were the following: The Differential Equations of Nuclear Induction, F. Bloch and R. K. Wangsness. Coincidence Studies on the Decay of Hf^{181}, W. C. Barber. The Magnetic Moment of the Proton in Units of the Nuclear Magneton, C. D. Jeffries. Chemical Analysis by Proton Scattering, S. Rubin and V. K. Rasmussen. A Nuclear Induction Radiofrequency Spectrometer, W. G. Proctor and F. C. Yu. High Energy Deuteron Break-Up, L. I. Schiff. Nuclear Induction Apparatus for Observing Signals in Gases, M. E. Packard. Production of Mesons by X-rays, Part I: Experimental Method, R. Stephen White, Edwin M. McMillan, and Jack M. Peterson. Production of Mesons by X-rays, Part II: Experimental Results, Jack. M. Peterson, Edwin M. McMillan, and R. Stephen White. Production of Mesons by X-rays, Part III: Theory, Keith A. Brueckner. Transition Curves in Lead of X-rays, Causing Nuclear Reactions. I. Experimental, K. Strauch. Transition Curves in Lead of X-rays Causing Nuclear Reactions. II. Theoretical, L. Eyges. Design of the Bevatron Quarter Scale Operating Model, D. C. Sewell, W. M. Brobeck, E. O. Lawrence, and E. J. Lofgren. Bevatron Model Radiofrequency System, Q. A. Kerns, W. R. Baker, G. M. Farly, and J. Riedel. Bevatron Model Operating Results, E. J. Lofgren, W. M. Brobeck, E. O. Lawrence, and D. C. Sewell. Theoretical Discussion of the Performance of the Model Bevatron, Lloyd Smith, A. A. Garren, and L. R. Henrich. An Experiment for Measuring Heavy Meson Production by High Energy Particles, H. A. Wilcox and C. Richman. Measurement of the Production of Positive and Negative π-Mesons by 345-Mev Protons on Carbon, C. Richman and H. Wilcox. Measurement of Production of Positive and Negative π-Mesons in Lead by 345-Mev Protons, Mitchel Weissbluth. Energy and Angular Distribution of π-Mesons Produced by 350-Mev Protons, T. B. Taylor and G. F. Chew. Nuclear Disintegration under Different Absorbers, H. Sun and Harriet H. Forster. The Positive-Negative Ratio for π-Mesons Produced in Company Nuclei, Geoffrey F. Chew and Jack L. Steinberger. Observations on Tracks in Electron Sensitive Emulsions, Frank L. Adelman. Nuclear Cross Sections for X-rays from the Berkeley Synchrotron. A. C. Helmholz and K. Strauch. Observations on Grain Counting and the Photographic Emulsion, J. Kent Bowker. Production of C^{11} and C^{12} by High Energy Particles, Lee Aamodt, Vincent Peterson, and Robert Phillips. The Beta-Spectra of Zn^{65} and Cu^{62}, Raymond W. Hayward. Showers Initiated by 335-Mev Bremsstrahlung, Wade Blocker and Robert W. Kenney. A Fast Neutron Spectrometer Employing Li^6 Impregnated Emulsions, G. R. Keepin, Jr., and J. H. Roberts. Measurement of Protons Produced in the Synchrotron Beam, A. Silverman and C. Levinthal. Excited States of the Mirror Nuclei Be^7 and Li^7, A. B. Brown, C. Y. Chao, W. A. Fowler, and C. C. Lauritsen. Gamma-Radiation from an Excited State of Be^7, T. Lauritsen and R. G. Thomas. Gamma-Radiation from C^{13} + d, R. G. Thomas and T. Lauritsen. The Low Energy α-Particles from $F^{19}(p\alpha)O^{16}$, C. Y. Chao, A. V. Tollestrup, W. A. Fowler, and C. C. Lauritsen. Production and Annihilation of Antiprotons, C. W. Helstrom. Further Remarks on Neutron Optics, Otto Halpern, and Charles B. Shaw, Jr. A Proposed Decay Scheme for $_{72}Hf^{181}$ (46-day, 5.7 hr), S. B. Burson and K. W. Blair. Proton-Proton Scattering at 12.5 Mev, Byron T. Wright and F. E. Faris. High Energy Scattering — Theoretical, Richard S. Christian. A Multiple Scattering Deflector for the 184-Inch Cyclotron, C. E. Leith. Absorption of π^--Mesons in Hydrogenous Materials, W. K. H. Panofsky and H. F. York. High Energy Photons from Proton Nucleon Collision, W. E. Crandall, B. J. Moyer, and H. F. York. Non-Equilibrium Cyclotron Orbits, Walter H. Barkas. Ratio of Positive to Negative π-Meson Yields from Various Targets Bombarded by 345-Mev Protons, H. Bradner and S. B. Jones. Phenomenological Interpretation of p-p Scattering at 32 Mev, H. P. Noyes. Auger Effect in the Decay of At^{211}, Lawrence S. Germain. An Iteration Procedure in the Rayleigh-Ritz

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Principle, E. Gerjuoy. Mass Measurements of Cosmic-Ray Particles, T. C. Merkle, Jr., E. L. Goldwasser, and R. B. Brode. The Ratio of Positive to Negative Particles in the Cosmic Radiation at 3650 Meters Elevation, R. B. Brode. Production of Penetrating Showers in Carbon, John R. Green, and W. B. Fretter. Extensive Showers under Water, W. B. Fretter and John Ise, Jr. Photographic Evidence for the Existence of a Meson of More than 450 Electron Masses, Harriet H. Forster. Preliminary Results—Operation of a High Power Electron Linear Accelerator, R. F. Post. A Constant-Mass Electron in Uniform Fields, F. W. Warburton.

818 Temperature Effects in the Diffusion of Real Gases. Leonhard Miller. Z. Naturforsch. 4a, 262-5(1949) July (in German).

The thermal diffusion effect taking place during diffusion of pure hydrogen with pure nitrogen in a closed cylinder was measured by means of a string galvanometer. The temperature field, variable in time, is reconstructed, and there are indications of a finite negative heat of mixture which is also to be expected from thermodynamic calculations. The maximum changes of temperature occurring in connection with diffusion are given for several other gas pairs. Furthermore, observations are reported on temperature changes occurring in connection with diffusion from an open cylinder into free space.

819 The Thermodynamics of Liquid Helium on the Basis of the Two-Fluid Theory. O. K. Rice. Phys. Rev. 76, 1701-7(1949) Dec. 1.

The thermodynamics of liquid helium is developed in the light of the two-fluid theory, which says that below the λ-point liquid helium consists of two "phases," one a superfluid phase and one a phase of normal fluid; and the thermodynamic consequences of assuming these phases to be in equilibrium with each other are worked out. It is pointed out that there is some evidence that these phases are separated not only in momentum space, as in London's theory based on the Bose-Einstein gas, but also in ordinary space. The specific heat just above the λ-point is considered on the assumption that in this region superfluid is beginning to appear in the form of small globules; it is estimated that these globules contain about 60 to 80 helium atoms. The thermodynamic properties below the λ-point are used to estimate the entropy of mixing of the two fluids in this region. The results suggest that in this region the superfluid forms a "partially condensed system," having possibly a fibroid structure. The nature of the second-order transition at the λ-point with pressure, and the change with concentration of He^3 is also considered. The thermodynamic results, though discussed in the light of the hypothesis that the two phases separate in ordinary space as well as momentum space, depend for the most part only on pure thermodynamics and the mere existence of two phases.

820 Self-Diffusion in Argon. Franklin Hutchinson. J. Chem. Phys. 17, 1081-6(1949) Nov.

The self-diffusion coefficient of argon was measured at five different temperatures between −183 and 53.5°C by observing the diffusion of radioactive A^{41} into normal argon. The decrease in the observed diffusion coefficient caused by the larger mass of A^{41} was deduced and found to be 0.6%. The experimental values are compared with several theoretical calculations. In particular, it is shown that use for argon of an inverse power model ($V \propto r^{-\nu}$), with different values of ν ascribed to different temperature ranges, is not permissible since widely different values of ν at the same temperature can be obtained from different experimental data. The experimental figures agree very well with numerical calculations by Hirschfelder, Bird, and Spotz (J. Chem. Phys. 16, 968(1948)) based on an interaction potential of the form $4E\left[-(r_0/r)^6 + (r_0/r)^{12}\right]$.

821 Scintillation Studies on Potassium Iodide. B. Smaller. AECU-593(UAC-160), nd. 1p.

This document is in abstract form; it is reproduced below in its entirety.

Scintillation studies have been conducted on the effect of thallium impurity on the fluorescence properties of potassium iodide. Coincidence techniques have demonstrated the presence of single photon emission as expected from electron trapping at impurity sites. It has been possible to distinguish between the characteristic radiation due to the impurity and the fundamental or lattice radiation from the pure potassium iodide crystal. The fluorescence efficiencies of both types of emission have been determined as a function of temperature. Measurements of the K^{40} radioactivity in the crystal result in the values $\lambda(\beta) = 3.92 \times 10^{-10}$ per year and $\lambda(\gamma)/\gamma(\beta) \cong 0.04$. Comparison of pulse height distribution with that from Cs^{137} activity gave a provisional $E_{max}(\beta) \simeq 1.3$ Mev.

822 The Measurement of Low Energy Beta Ray Emitters — Ionization Chamber Techniques. Norman A. Bailey. AECU-650(CUF-4), Nov. 15, 1949. 16p.

Methods are presented for the measurement of low energy beta-ray emitters at various levels. The assay of both liquid and gaseous samples is discussed. The design of chambers which are suitable for this purpose is indicated by drawings. The importance of an easily reproducible geometry and an absolute determination of ionization current is stressed. The minimum amount of radioactivity measurable with these chambers is in the case of liquids about 1 microcurie and in the case of gases about 10^{-10} curie. Tabulated data for 10^{-9} curie of $C^{14}O_2$ show that with this amount of radioactive carbon, readings can be duplicated over a "period of days" with a maximum error of about 2-3 % and a probable error of somewhat better than 1 %. Both chambers are "windowless" and, therefore, with a given geometry a maximum number of electrons is utilized in producing ionization. The setup for gases involves two chambers connected in such a way as to cause the effect of background radiation to cancel itself while the radioactive sample causes ionization in one of them.

823 Construction and Calibration of Equipment for Measuring the Surface Exposure of Phosphorus-Bakelite Beta-Ray Sources. C. W. Sheppard and R. K. Abele. AECU-655(ORNL-265), Oct. 28, 1949. 43p.

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An improved ionization chamber for measuring the surface exposure rate of phosphorus-bakelite β-ray plaques has been calibrated by measurements with an extrapolation chamber. The design of both instruments is described in detail. The calibration involves the determination of the effective volume V_{eff} of the ionization chamber. This is the volume of air in a standard free-air chamber which would produce the same ion current when irradiated with an x-ray beam whose exposure rate in roentgens is the same as the surface exposure rate in rep of the plaque which is being measured. The volume is related to the basic quantities which enter into the calibration through the equation: $V_{eff} = AS_{air} I_{s.c.} S (dI/dt)_{ext}$. A is the area of the collecting electrode of the extrapolation chamber. S and S_{air} are the mass stopping powers of the irradiated material and air, respectively. $I_{s.c.}$ is the current in the ionization chamber produced by a given plaque. $(dI/dt)_{ext}$ is the extrapolated slope of the curve of ionization versus spacing in the extrapolation chamber produced by the same plaque under the same conditions and corrected for the absorption of radiation in the thin membrane accelerating electrode. The determination of these individual factors is discussed and a final value of V_{eff} is given which is reproducible and constant over an extremely wide range of plaque intensity. The overall probable error is estimated to about $\pm$ 2%. Close agreement is obtained between surface exposure rates determined both by this method and by calculation from determinations of activity per gram of plaque material.

824 Delays in Rectangular Geiger Counters. G. E. Bradley and M. L. Wiedenbeck. Rev. Sci. Instruments 20, 841-2(1949) Nov. (Laboratory and shop note).

Counters of rectangular geometry have recently been used for applications in which this shape is convenient. When such counters are used for coincidence measurements, the delay in the initiation of the discharge limits the resolving time. This delay, as well as the efficiency of a rectangular counter, has been determined as a function of the position of the initiating event. Delay and efficiency curves are given as a function of this position.

825 Determination of the Efficiency of a Geiger-Mueller Counter Used for Cosmic-Ray Investigations. Mario Alves Guimarães and Palmyra Amazonas Sampaio. Anais acad. brasil. cienc. 21, 229-37(1949)(in Portuguese).

Measurements were made of the interval between the end point of the dead time of a Geiger-Mueller counter and the end point of the recovery time, the said interval depending on the characteristics of the counter, the quenching system, and the sensitivity of the detector circuit. The instrument used was a four-counter telescope recording cosmic radiations, and the efficiency η of the counters for those radiations was assumed to be equal to one. The results obtained by this method disagreed with direct observations on the oscillograph, and the discrepancies were attributed to the differences between the real and the assumed values of η. A method is based on this for the calculation of the real η.

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826 Determination of the Energy of a γ Radiation from the Absorption of Monoenergetic Compton Electrons. Jacques Jacqesson and Armand Lataste. Compt. rend. 229, 38-40(1949) July 4 (in French).

Under the impact of photons of energy $h\nu$, the Compton electrons projected at a definite angle ϕ have an energy $W = \frac{2\alpha . h\nu}{1 + 2\alpha + (1 + \alpha)^2 tg^2\phi}$, where $\alpha = h\nu/m_0c^2$. A definite ϕ can be realized by giving an appropriate shape to the radiator of Compton electrons; the authors used a "keg" surface, i.e., a surface of revolution described by an arc of circle around a larger chord. W is measured by absorbing the electrons in Al; since the electrons are monoenergetic, the absorption curve is a straight line. This permits the determination of the range by extrapolation in the case of a predominating γ line, and also, in certain favorable cases, the determination of several γ radiations from the points of intersection of the corresponding straight lines which together form the absorption curve. The radiator keg was of Al, 0.1 mm thick. The effective angle ϕ was determined by using the 2.62-Mev line of ThC(Bi^{212}). Three lines of RdTh (Th^{228}) (2.62, 1.78, and 1.35 Mev), and three lines of Ra (1.85, 1.14, and 0.640 Mev), were measured, in satisfactory agreement with the principal line groups found by Ellis (Proc. Roy. Soc. 138, 318(1932)). The method is applicable to γ energies > 0.5 Mev. For smaller energies, another procedure, based on the use of photoelectrons, is under study.

827 Experiments in the Possibility of Increasing the Efficiency of Gamma Counters. Hilding Slätis. Arkiv Mat. Astron. Fysik 36 A, No. 17 (1949) 12p.

Results, which were reported elsewhere (Rev. Sci. Instruments 20, 353(1949); NSA 3-439), are given in greater detail.

828 A Focusing Phenomenon in the Application of the Method of the Trochoid to the Continuous Beta-Ray Spectra. Joseph Lafoucrière. Compt. rend. 229, 1005-7(1949) Nov. 14 (in French).

If a point source of charged particles is placed in the gap of an electromagnet producing an inhomogeneous field with axial symmetry, and if its distance from the axis of symmetry is r, a focussing phenomenon takes place on a circle of radius r (Compt. rend. 229, 823(1949)). The trajectories of the particles are described in some detail, and possible applications to beta-ray spectrographs are noted.

829 A Germanium Counter. Kenneth G. McKay. Phys. Rev. 76, 1537(1949) Nov. 15 (Letter to the editor).

When insulating crystals are used as counters, the trapping of mobile charge carriers in the crystal broadens the pulse height distribution, and gives rise to internal space charge fields. These effects may be avoided by using a thin crystal with a high electric field, or by using the barrier layer in a semiconductor which acts in a similar manner. The conditions required for the use of the barrier layer in germanium under a point contact were analyzed, and a circuit satisfying these conditions was constructed. A polonium source was placed near the point of contact and the pulse height distribution was observed. The counters were found to have a fast

rise and recovery time, and responded effectively only to high ionization particles.

830 Investigation of Nuclear Photo-Reactions in Light Elements with the Photographic Method. H. Wäffler and S. Younis. Helv. Phys. Acta 22, 414-17(1949) (in German).

The general experimental procedure used in the investigation of photo-reactions in light elements by means of the photographic method is discussed. The results given are (a) the cross section for the reaction $C^{12}(\gamma,\alpha)2\alpha$ is $1.1 \pm 0.3 \times 10^{-28}$ cm², (b) the cross section for the reaction $D^2(\gamma,n)p$ is 8 ± 3.10^{-28} cm², and (c) the angular distribution of deuterium photo-protons, which can be written $I(\theta) \sim a + \sin^2 \theta$, θ being the angle between γ ray and photo-proton. The isotropic component is found to be: $a = 0.05 \pm 0.15$.

831 On the Conductivity Produced in CdS Crystals by Irradiation with Gamma-Rays. Rudolf Frerichs. Phys. Rev. 76, 1869-75(1949) Dec. 15.

By combining the theory of secondary photo-currents with the model of a crystal phosphor, a theory of the photo-conductivity in CdS crystals is given. The theory agrees qualitatively with the results of previous and present experiments. A quantitative energy scheme, which is the basis for this theory, has been determined from measurements of the emission and absorption spectra of these crystals. According to the new determined sign of the thermal emf: CdS against Cu, the photo-current in CdS is predominantly carried by electrons. The dark current follows the usual law: $\log \sigma \sim 1/T$ with the constants $\epsilon = 0.67$ ev and $\sigma_0 = 1.7 \cdot 10^{-3}$ mho cm^{-1}. In accordance with the theory the final current reaches after prolonged irradiation is proportional to the square root of the intensity of irradiation. The final current follows the Ohm law. The initial slope of the decay curve is proportional to the intensity of irradiation. Under periodical irradiation with γ rays the amplitude of the resulting alternating current slowly increases to a final value. If the electric field is temporarily removed, the original conductivity is slowly restored. When a CdS crystal is heated and then cooled to liquid air, temperature irradiation produces a small primary current of less than 10^{-13} amp at first. With continuous irradiation and after a slight delay this current suddenly increases until it reaches a constant value of 10^{-8} amp. 32 references.

832 On the Photo-Electric Properties of Cadmium-Sulfide Single Crystal. J. Fassbender. Ann. Physik 5, 33-50(1949)(in German).

The characteristics of photo-conduction in cadmium sulfide single crystals can be interpreted on the basis of the energy band model of Riehl and Schoen (Z. Physik 114, 682(1939)), if one applies the concepts of metallic conduction to photo-electrons. The amplification effect is considered due to a space charge effect in front of the cathode, which makes possible conduction similar to that in metals. A relation can be derived between photo-current, absorption coefficient, and thickness of the layer in which photo-conduction takes place, which explains the occurrence of a selective maximum

of the photo-electric effect as a function of the thickness of the layer. Experimental results were obtained which are in qualitative agreement with the theory proposed.

833 A Sensitive Directional Gamma Ray Detector. Benedict Cassen, Lawrence Curtis, and Clifton W. Reed. UCLA-49, Nov. 29, 1949. 11p.

When a Geiger counter for γ-ray detection is used with a lead collimator so that only a small solid angle is received by the counter, the overall sensitivity becomes so low that it cannot be satisfactorily used with biological tracer doses of γ-emitting radiosotopes. The principal factor causing low sensitivity is the poor absorption of the penetrating radiation by the sensitive elements of the counting tube. Newly available calcium tungstate crystals will absorb most of the incident radiation in a small volume, and a significant number of the scintillations produced in these crystals by recoil electrons are so bright that they are easily detectable with a good signal-to-noise ratio by a photomultiplier tube. The development and testing of an instrument making use of this principle is described. The overall sensitivity of the method is greatly increased over previous methods and should enable new experiments and techniques with radioiodine, radiosodium, and other γ emitters.

834 Standardized Radiation Instruments for Army Training use. Charles De Vore. Instruments 22, 902(1949) Oct.

Two radiation survey instruments intended for use by the Army Field Forces, with a possibility of adoption by the Navy and the Air Force for training use, are discussed. Military requirements of compactness, serviceability under field conditions, use and maintenance by soldiers, and operation under atmospheric extremes, were design considerations that determine equipment specifications recently completed by the Signal Corps. The work was done in cooperation with the Radiological Defense Division of Armed Forces Special Weapons Project. One of these equipments, known as the Radiac Training set AN/PDR-T1-( ), is an ionization chamber to measure γ-radiation intensities from 0.5 to 50,000 milliroentgens (mr)/hr. The second, designated as Radiac Training Set AN/PDR-T2-( ), is a Geiger-Mueller type counter for detecting γ and β radiations with γ intensities varying from background to 50 mr/hr. The requirements of the two instruments are discussed. These included high resistance to moisture, temperature and pressure stability, accessibility of parts, and ability to withstand vibration and shock. The type of plateau desirable and the time constants of the instruments are also treated.

835 Study of Photoelectrons in Photographic Plates. Jacques Blum. Compt. rend. 228, 918-20(1949) Mar. 14 (in French).

Photoelectrons were emitted in photographic plates through the action of monochromatic x rays. Kodak NT2a plates were placed tangent to the focal circle of a curved crystal spectrograph and irradiated. The length of the tracks was then measured and found to fall into three groups. The author concludes that the shortest tracks were produced by elec-

trons from the K shell of bromine, the next group by electrons from the L shell of silver and iodine, and the longest tracks by electrons from light atoms as well as those from outer shells of heavy atoms. The author plots the length of the tracks as a function of the electron energy and finds that his results agree with those obtained by other methods. The author also found short and heavy tracks of Auger electrons, and a number of two- and three-branch stars whose origin is difficult to explain.

836 The Theory of Counting Experiments Using Pulsed Sources: Chance Coincidences and Counting-Rate Losses. N. Feather. Proc. Cambridge Phil. Soc. 45, 648-59(1949) Oct.

The use of artificially pulsed sources introduces complications into counting experiments, since it is no longer possible to assume that the distribution of ionizing events in a counter is strictly random. This paper is a study of chance coincidences and counting rate losses for the types of nonrandom sequences which characterize the time distributions of ionizing events in counters employed with pulsed sources.

837 Absorption of γ-rays. W.S. Snyder and J.L. Powell. AECD-2739, Nov. 7, 1949, Decl. Nov. 25, 1949. 18p.

Tables of absorption coefficients as functions of γ-ray energy and atomic numbers have been compiled for Al, Fe, Cu, Ag, Sn, Ta, Pb, and U; they are representative of the best experimental data available at the present time. It was found that except for limited ranges of the variables involved, the theoretical formulas that have been developed for calculating absorption coefficients cannot in general be relied on to give absorption coefficients within an accuracy of 5%. The various approximations which enter into the theoretical calculations of cross sections for photoelectric and Compton absorption and for pair production are discussed in detail. 16 references.

838 Neutron Data for Water Shielding. H. Feshbach. AECD-2755, Sept. 1, 1949, Decl. Dec. 7, 1949. 11p.

This report is one of a series on the shielding problem and represents part of the work of a group at the Oak Ridge National Laboratory during the summer of 1949. Recent published literature on the total and inelastic cross sections of oxygen, and the angular distribution, energy dependence, and triplet cross section of the $H^3 + d$ reaction are discussed and interpreted in light of water shielding for neutrons.

839 Range-Energy Curves. W.A. Aron, B.G. Hoffman, and F.C. Williams. AECU-663(UCRL-121, 2nd Rev.), 1949. 104p.

The document is a revision of AECU-103, which has been listed in Nuclear Science Abstracts as Abstract 2-1165.

840 The Calculation of X-ray Mass Absorption Coefficients. John A. Victoreen. J. Applied Phys. 20, 1141-7(1949) Dec.

An empirical method of calculating x-ray mass absorption coefficients is given. Complete tables of constants are presented for calculating μ/ρ for all elements and for wavelengths less than the K critical absorption wavelength. Partial tables give constants for wavelengths between the L_1 and M_1 critical wavelengths. Calculated mass absorption coefficients are given for the common elements.

841 Collimation Error in Small Angle X-ray Scattering. K. L. Yudowitch. J. Applied Phys. 20, 1232-5(1949) Dec.

It has been shown that excessive error may be introduced in small angle x-ray scattering by the use of an incident beam of finite cross section. To account for this error the usual procedure has required multiple integrations for rays reaching a single point P on the film from all points within each slit. However, the common effect from both finite slit height and width is a range of scattering angle for rays reaching P. The integrations over each slit dimension are reduced to a single integration over scattering angle, which entails finding the limits of scattering angle. The assumption of a constant distribution of intensity throughout the range allows the range of scattering angle $\delta\epsilon$ to be taken as a measure of the collimation error. Minimization of $\delta\epsilon$ permits determination of optimum values of slit height-width ratio. For two-slit collimation, it further leads to determination of optimum slit spacing and optimum relative slit sizes.

842 Influence of a Homogeneous, Longitudinal Magnetic Field on Radiation Produced by a Radioactive Source. Félix Ehrenhaft and R. F. K. Herzog. Compt. rend. 228, 550-1(1949) Feb. 14 (in French). (See also NSA 2-9.)

The authors refer to a previous experiment (Compt. rend. 227, 626(1948)) which indicates that the penetrating power of RaE (Bi^{210}) radiation is increased in the presence of a homogeneous, longitudinal magnetic field. The experiment was modified to eliminate the effect of magnetic focusing. Nevertheless, it was noted that the penetrating power of the radiation was greatly increased by the presence of the field. Two mm of Al were used as absorber and Ilford Q_1 plates were used to record the radiation intensity.

843 Investigations on the Elastic Scattering of Slow Electrons in Helium, Neon, and Argon. Sverre Westin. Trondheim, I Kommisjon Hos F. Bruns Bokhandel, 1949. 142p.

This investigation of the elastic scattering of slow electrons consists of four major parts: (1) a treatment of the general theory of electron scattering, which leads to a general formulation of the results of a rigorous theory; (2) an outline of the method of checking experimental data with the general theory and a description of an electrical analyzer which was designed for that purpose; (3) a report of an experimental investigation for obtaining the absolute angular distribution scattering coefficients needed for a check of the theory along these lines; (4) a comparison of the experimental data with the general theory and a successive deduction of the phase parameters from the experimental data. 107 references.

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844 Magnetite Concrete for Radiation Shielding. E. Creutz and K. Downes. J. Applied Phys. 20, 1236-40 (1949) Dec.

A concrete containing only magnetite ore concentrate, cement, and water is found to have appreciably better shielding properties than ordinary concrete, and to possess good strength and ease of handling. Exceptionally high moisture content, although gradually lost by diffusion, decreases by only about 50% in thirty years in an eight-foot thick wall. Its use is desirable under certain conditions because of space economy due to its high density.

845 Multiple Diffuse Small Angle Scattering of X-rays. David L. Dexter and W.W. Beeman. Phys. Rev. 76, 1782-6(1949) Dec. 15.

The problem of multiple x-ray scattering from spherical particles of radius much larger than the wavelength is treated using the Guinier approximate scattering function. The total scattered intensity is found to be a sum of Gaussians in the polar angle with coefficients dependent on the sample thickness. A method is discussed for determining particle sizes from the variation of the width of the scattering curve with sample thickness. Experimental results are given for two carbon blacks.

846 On the Absorption of 17-Mev Electrons in Materials of Different Atomic Number. M. Ageno and M. Chiozzotto. Atti accad. naz. Lincei. Classe sci. fis. mat. e nat. 5, 401-4(1948) July-Aug. (in Italian). (See also NSA 3-1600.)

A study of the absorption in paraffin, Fe, Cd, and Pb of a mono-energetic beam of 17-Mev electrons has been made with good geometry. The results indicate greater penetration for smaller atomic numbers.

847 Range-Energy Curve for α-particles of About 2-Mev Energy. J. Walker. Nature 164, 837-8(1949) Nov. 12 (Letter to the editor).

A recent communication by Jesse and Sadauskis (Phys. Rev. 75, 1110(1949)) is discussed in which corrections to the Livingston and Holloway range-energy curves for α particles were proposed. The corrections are based on the assumption that ionization is proportional to energy for an α particle in argon but not for an α particle in air. It is noted by the author that in previous experiments the ranges in standard air of low-energy α particles have been obtained from measurements, in some suitable gas, of the ranges of these particles and of polonium α particles. The reduced range has been obtained from the measured ranges without any correction for the variation with velocity of the α particle of the stopping power of the particular gas relative to air. For the $B^{10}(n,\alpha)Li^7$ reaction, quoted by Jesse and Sadauskis in support of their proposals, the correction gives an increase of 8% in the α-particle range, and is thus very important when considering modifications to the range-energy curve. A further interesting feature is noted which would also disprove the results obtained by the aforementioned authors. Experiments are in progress which, if substantiated, suggest either that the nuclear masses are incorrect or that the assumption of proportionality between energy and ionization for α particles in argon is not justified.

848 The Stopping Power for Protons in Several Metals. S.D. Warshaw. Phys. Rev. 76, 1759-65(1949) Dec. 15.

The rate of energy loss of low velocity (i.e., from 50 to 400 kev) protons has been measured in five different stopping materials: Be, Al, Cu, Ag, and Au. Agreement with previous measurements at higher velocities (greater than 400 kev) is good where such measurements have been published. The stopping measurements were made on foils prepared by an evaporation technique and are believed to be more accurate than measurements made on the usual (hammered or rolled) foils; the results give a value for stopping about 15% higher (in Au) and about 7% lower (in Al) than those published by Wilcox (Phys. Rev. 74, 1747(1948)). A comparison to existing theory at very low and at high velocities (the critical velocity being defined as $e^2/\hbar$) was made with good agreement shown at the low end. The high end theory is of doubtful validity and gives a stopping power about 10% higher than observed. It is argued that this discrepancy cannot be accounted for by a proton charge less than unity due to the electron capture-loss process.

849 A Verification of the Formula of Klein and Nishina at 2.62 Mev. Mario Ageno, Mario Chiozzotto, and Ruggero Querzoli. Atti accad. naz. Lincei 4, 319-25(1949)(in Italian).

An experimental verification of Klein-Nishina's formula was made by determining the coefficients of total absorption μ of monochromatic γ rays in various substances and by comparing the measured values with those calculated from $\mu = \sigma + k + \tau$, where σ, k and τ are coefficients of absorption due, respectively, to the Compton effect, pair creation and photoelectric effect; these three coefficients are given, respectively, by the formulas of Klein and Nishina (Z. Physik 52, 853(1929)), Bethe and Heitler (Proc. Roy. Soc. (London) 146 A, 83(1934)), and Hulme et al (Proc. Roy. Soc. 149 A, 131(1935)). The γ radiation used was the line 2.62 Mev of ThC'' (Tl^{208}) (from a MsTh (Ra^{228}, Ac^{228}) source). The absorbing substances were Al, Cu, Sn, Pb, C, paraffin $C_{34}H_{50}$; from the values obtained for the two last named substances, the value of μ for H was derived. The results showed a good agreement, (within 1%), between the calculated and measured values of μ; the authors concluded that the formula of Klein and Nishina, for 2.62 Mev γ rays, gives the values of σ with the same approximation of 1%.

850 Neutron Deficient Radioactive Isotopes of Tantalum and Tungsten. Geoffrey Wilkinson and Harry G. Hicks. AECU-585(UCRL-420), Aug. 18, 1949. 24p.

A study has been made of neutron deficient radioactive isotopes of tantalum and tungsten. Bombardments were made, using the 60-in. cyclotron, of lutecium with 20, 30, and 38-Mev α-particles, and of hafnium with 10-Mev protons; tantalum was bombarded with deuterons and protons of various energies using the 184-in. cyclotron. Four new radioactive isotopes of tantalum (8.0 ± 0.1-hr Ta^{175}; 2.50 ± 0.05-day

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Ta^{177}; 15.4 ± 0.2-day Ta^{178}; ~ 120-day Ta^{179}) and three of tungsten (130 ± 3-min W^{177}; 30 ± 1-min W^{179}; 21-day W^{179}) have been characterized; evidence has been obtained for the existence of an unreported stable isotope of tungsten, W^{178}. The 8.00 ± 0.05-hr and 16 ± 2-min Ta^{180} have been reexamined.

851 Neutron Deficient Cesium Isotopes. Richard W. Fink, Frederick L. Reynolds, and D. H. Templeton. AECU-626 (UCRL-397, Rev.), Oct. 13, 1949. 13p.

This is a revision and condensation of AECU-394. An abstract of AECU-394 was listed as NSA 3-1310.

852 Radioactive Isotopes of the Rare Earths Elements. III. Lutecium Isotopes and Hafnium Isotopes. Geoffrey Wilkinson and Harry G. Hicks. AECU-629 (UCRL-429), Aug. 30, 1949. 29p.

Radioactive isotopes of lutecium and hafnium, produced by bombardments of thulium and ytterbium with 38, 31, and 19-Mev α-particles, of lutecium and hafnium with 19-Mev deuterons, and of tantalum with 190-Mev deuterons, have been isolated by chemical means and their characteristics studied. The isotopes observed include 3.75-hr Lu^{176}, 6.70-day Lu^{177}, 160-day Lu^{174}; 2.1 ± 0.1-day Lu^{170}, 8.5 ± 0.2-day Lu^{171}, 500 ± 20-day Lu^{172}, 4.0 ± 0.1-hr Lu^{172}, 3.40 ± 0.05-day Lu^{172}, 6.7 ± 0.1-day Lu^{173}, 5-yr Hf^{171}, 22.0 ± 0.5-hr Hf^{172}, > 50-day Hf^{172}.

853 RaDEF Standard Sources for Beta Disintegration Rate Determinations. Theodore Novey. AECU-637 (UAC-162), nd. 19p.

The preparation and use of calibrated RaDEF (Pb^{210}, Bi^{210}, Po^{210}) equilibrium sources for absolute β counting is described. The sources are essentially weightless and are mounted on a thin backing to avoid self absorption and back-scattering correction problems. Calibration was done by determination of the α-disintegration rate of RaF in a parallel plate alpha ionization chamber. No secondary standards are required and the sources can be recalibrated at any time. As an example of the application of such standards, details of the calibration of a P^{32} solution distributed by the Bureau of Standards for intercalibration in February 1949 are given. The final result is 88.8 mrd/ml at 8 A.M.C.D.T. 3/1/49. The precision of the measurement is 0.3%. The accuracy is estimated to be 1-2%.

854 Low Mass Francium and Emanation Isotopes of High Alpha Stability. E. K. Hyde, A. Ghiorso, and G. T. Seaborg. AECU-654(UCRL-469), Oct. 10, 1949. 30p.

Isotopes of francium with 126 or fewer neutrons have been searched for in bombardments of Th^{232} with 350-Mev protons from the 184-in. cyclotron. Fr^{212} with an apparent half-life of 19.3 min. for branching decay by α emission (44%) to At^{208} and by orbital electron capture (56%) to Rn^{212} has been found. Rn^{212} is shown to be a 23-min α emitter. At^{208} decays primarily (99.5%) by orbital electron capture to Po^{208} but shows 0.5% α branching. The francium and radon isotopes have α half-lives completely at variance with the predictions based on the previously known isotopes of these elements. Their high α stability is believed to be due to a closed shell of 126 neutrons in analogy to the behavior of elements 83-85. The nonexistence of long-lived francium in nature is discussed in the terms of this and other recent work on francium isotopes. 18 references.

855 Activity of Silver Irradiated with 6.5-Mev Deuterons, at Depths Exceeding the Latter's Range. Catherine Chamié, Henriette Faraggi, and Roger Nataf. Compt. rend. 229, 422-3(1949) Aug. 8. (in French).

A pile of thin Ag plates was irradiated for 45 min with 6.5-Mev deuterons. Thirty minutes later, relative intensities, absorptions, and decays of individual plates were measured. The results of these measurements, as well as the chemical analysis of the plates and observations in photo-emulsions, showed that there exists in Ag, beyond the range of the deuterons, a region of about 300 mg/cm² in which protons are present and Cd^{107} is formed, at certain well defined depths, by a process involving resonance captures.

856 Angular Correlation between Short-Range α particles and γ Quanta. L. A. Kul'chitskiĭ, G. D. Latyshev, and D. G. Bulyginskiĭ. Doklady Akad. Nauk S.S.S.R. 64, 57-60(1949) Jan. 1 (in Russian).

Chang (Phys. Rev. 69, 60(1946); 70, 632(1946)) has found that the intensities of short-range α rays of Po and Ra are considerably higher than the values given by the Geiger-Nuttall law. This can be explained by assuming surface vibrations of α-radioactive nuclei, which produce deformations and corresponding lowerings of the potential barrier in certain directions. In this case an angular correlation should exist between the short-range α ray and the accompanying γ quantum. The authors checked this conclusion by applying the coincidence method to the α and γ radiations of a mixture of RdTh (Th^{228}) and ThC (Bi^{212}). Maxima of coincidence numbers occur at angles 45 and 135 deg., with lesser maxima at 0 and 180 deg. Theoretical considerations show that in cases (like the one investigated) where the nuclear spin before and after the α and γ emissions is zero, the angular correlations are uniquely determined whatever the deformation caused by the vibration; in other cases, the correlation depends on the kind of the deformation. Therefore, it would be interesting to investigate the case of Pa, whose nuclear spin is not zero and the decay exhibits intensive groups of short-range α particles.

857 Angular Correlation of Delayed Radiations. Arne Lundby. Phys. Rev. 76, 993-4(1949) Oct. 1. (Letter to the editor).

An experimental arrangement is shown which was used to record delayed coincidences from a Hf^{181} source at angles 90 and 180 deg. between the counters. The delay introduced in channel A was 2 μsec, while the sum of the effective pulse lengths in the two channels was 1.9 μsec. The Geiger counters in the A and B channels had mica windows of 3 and 1.6 mg/cm², respectively. The angular resolution was about ± 9 deg. The genuine delayed coincidence rates were found to be 0.018 ± 0.0017 conversion electrons/min and 0.02 ±

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0.0029/min in the 90 and 180-deg. positions, respectively. The random coincidence rate amounted to one fourth of the genuine coincidence rate. It is noted that the possible deviation from isotropic distribution must be less than 15%, although it is noted that for various reasons it is quite probable that the distribution actually should be symmetrical. Further investigations of the angular correlations of the radiations preceding a short-lived state (e.g., Ta^{181*}, Te^{121*}, Tm^{169*}, Tm^{171*}, Re^{187*}, Po^{213*}, RaC'*, etc.) and the radiations emitted from this state after the lapse of different time intervals are planned.

858 Angular Distribution of α Particles from the Li^7 (p, α) He^4 Reaction. L. H. Martin, J. C. Bower, D. N. F. Dunbar, and F. Hirst. Australian J. Sci. Research 2A, 25-38(1949) Mar.

An amplified version of a letter to the editor which appeared in Nature 164, 310(1949) Aug. 30, and was abstracted in Nuclear Science Abstracts as abstract No. 3-1586.

859 β^+ and β^- Decay of Br^{80}. B. S. Dzhelepov, N. M. Anton'eva, and S. A. Shestopalova. Doklady Akad. Nauk. S. S. S. R. 64, 309-12(1949)(in Russian).

A magnetic spectrometer is described in which the electron's trajectory is a spiral, the focusing taking place twice, after 1/2 and 3/2 loops, at which points two counters, working in coincidence, are placed one below the other. The counters' walls are of 20 μ cellophane; the whole instrument has a celluloid envelope, the pressure being 9 cm Hg within the envelope and the counters. Using this instrument, the β^+ - β^- decay of Br^{80} was investigated. The positron-spectrum end point is 1.0 ± 0.1 Mev; that of the electron spectrum agrees with the values found by other workers (Snell, Phys. Rev. 52, 1007(1937)); the ratio $\beta^+/\beta^- = (1.0 \pm 0.2)\%$. The half-life period of the $\beta^\pm$ decay is 5.0 ± 0.5 hr. Although this value is close to the period of Br^{80} (4.4 hr), it is probable that the positrons are connected, as are the electrons, with the ground state (τ = 18 min) of Br^{80}, rather than with the metastable level τ = 4.4 hr. The probability of a K capture was calculated by using the formulas of Konopinski (Revs. Modern Phys. 15, 209(1944)). The following scheme of the decay of Br^{80} is obtained: a γ transition (4.4 hr), then (1) 1.2% K capture, (2) 1% β^+ decay, (1.0 Mev), both (1) and (2) resulting in Se^{80}, or (3) 97.8% β^- decay (18 min), (2.2 Mev), resulting in Kr^{80}.

860 The Beta-Spectra of Cu^{64}. L. M. Langer, R. D. Moffat, and H. C. Price, Jr. Phys. Rev. 76, 1725-6(1949) Dec. 1 (Letter to the editor).

It has been reported (Cook and Langer, Phys. Rev. 73, 601 (1949); Wu and Albert, Phys. Rev. 75, 315, 1107(1949)) that the β spectra of Cu^{64} have more particles at low energies than is predicted by the Fermi theory of β decay, and that this discrepancy is a function of source thickness. These results had been derived from measurements using sources prepared from chemical solutions. The authors found that such sources may vary in intensity by a factor of as much as 100, so that an "average" source thickness becomes meaningless. Therefore, they re-measured the Cu^{64} spectra

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using sources prepared by thermal evaporation of metallic Cu in vacuo. Two sources were used, of 5 $\mu g/cm^2$ and 15 $\mu g/cm^2$ thickness, respectively. The first was completely uniform, while the activity from the other was uniformly distributed within a factor of 2, as indicated by an autoradiograph analysis. With the improved sources, there is no longer any real disagreement between the experimental spectrum and that predicted for an allowed transition by the Fermi theory.

861 Coefficient of Internal Conversion with Pair Emission for any Electric and Magnetic Multipole Radiation. I. S. Shapiro. Zhur. Eksptl. i Teoret. Fiz. 19, 597-604(1949) July (in Russian).

In several experimental works the phenomenon of internal conversion with pair emissions was applied to the study of nuclear levels of naturally radioactive substances (Alikhanov et al, Doklady Akad. Nauk. S. S. S. R. 20, 163(1938); J. phys. radium 4, 163(1936); Zhur. Eksptl. i Teoret. Fiz. 10, 985 (1940)). It is, therefore, important to have a better knowledge of the relationship between the coefficient of pair conversion and the polarity degree of the γ radiation. These coefficients are calculated by the present author, with the Born approximation, for electric and magnetic 2^l fields. It is shown that the Coulomb field does not affect the form of the relationship between the differential probability of the process and the polarity degree of the multipole radiation.

862 Coincidence Experiments in Ni^{65}, Ni^{57}, Ag^{110}, and In^{114}. Fred Maienschein and J. Lawrence Meem, Jr. Phys. Rev. 76, 899-903(1949) Oct. 1.

Coincidence and absorption measurements have been made on the radioactive isotopes Ni^{65}, Ni^{57}, Ag^{110}, and In^{114}. The Geiger-Mueller counters and coincidence amplifier used have been previously described (Phys. Rev. 76, 328(1949)). The arrangement of the counters with respect to the source was that generally used for coincidence and absorption measurements (Mitchell, Revs. Modern Phys. 20, 246(1948)). Absorption in aluminum of the β-radiation from Ni^{65} gave a maximum β energy of 1.97 Mev. β-γ coincidence absorption indicated another β-ray group at 0.46 Mev. γ-γ coincidences were obtained, and coincidence absorption of the Compton-recoil electrons gave γ rays of 1.64 and 0.3 Mev. The maximum energy of the positrons from Ni^{57} was found to be 0.72 Mev by absorption in aluminum. β-γ coincidences indicate the presence of only a single β ray group. γ-γ coincidences were obtained, and the energy of the most energetic γ ray was found to be 1.97 Mev. The β spectrum of Ag^{110} was shown to consist of β-ray groups of 0.09, 0.55 Mev and a very high-energy component of low intensity. β-γ coincidences showed that the most energetic group leads to the ground state. A large γ-γ coincidence rate was obtained, and the most energetic γ ray was found to have an energy of 1.48 ± 0.1 Mev. It was found that In^{114} emits a 0.196-Mev γ ray and a 2.05-Mev β ray, as has been shown previously. In addition, γ rays of about 0.5, 0.7, and 1.3 Mev were found. γ-γ coincidence showed that two of these are in cascade and β-γ coincidence absorption showed that they are not in coincidence with the 2.05-Mev β ray.

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863 The Complexity of α Radiation from Protactinium. Salomon Rosenblum, Eugène Cotton, and Georges Bouissières. Compt. rend. 229, 825-6(1949) Oct. 24 (in French).

Previous work by the same author (Compt. rend. 226, 171 (1948)) was repeated, with an improved source and counting technique. The source was prepared by a method described by Camarcat, Bouissières, and Haïssinsky (J. chem. phys. 46, 153(1949)) and was thinner than the one previously used. Density of α tracks is plotted as a function of the α energies, the data being taken from the best photographic plate. It is seen that the tracks fall into six principal groups, one of which was not reported in the previous article cited. The results support the conclusions of Meitner (Z. Physik 50, 15(1928)) and Teillac (Compt. rend. 229, 650(1949)), drawn from a study of the emission of particles presumed to be conversion elements.

864 The Decay Probability of Be^7 as a Function of the Ionization of the Atom. P. Benoist, R. Bouchez, P. Daudel, R. Daudel, and A. Rogozinski. Phys. Rev. 76, 1000-1(1949) Oct. 1 (Letter to the editor).

The results of various investigations in the United States and in France in which the decay constant of a radioactive element, Be^7, was found to vary as a function of the ionization of the atom, are summarized. It is noted that in general the decay probability of a compound, BeX, will vary inversely as the electro-negativity of the X atom and will vary directly as the density of the compound. The essential feature of the results is that for the first time it has been possible to influence the decay constant of a radioactive element.

865 The Decay Scheme of Hf^{181}. Arne Lundby. Phys. Rev. 76, 1809-11(1949) Dec. 15.

The radiations of Hf^{181} have been studied with delayed coincidence and absorption techniques. No γ rays are found to precede the formation of the 20-μsec metastable state in Ta^{181}, thus confirming the decay scheme of Chu and Wiedenbeck (Phys. Rev. 75, 226(1949)). From the values of the internal conversion coefficients together with delayed coincidence absorption measurements it is concluded that the previously reported 0.134-Mev γ ray is most probably emitted from another metastable state of about 1-sec duration in Ta^{181}. A theoretical discussion of the multipole order of the different radiations lead to assignments of probable spin and relative parity values to the excited states of Ta^{181}. Beginning with the ground state, the deduced spin and parity values are: $7/2(\pm)$, $1/2(\pm)$, $5/2(\pm)$, and $1/2(\pm)$.

866 Discussion of the 3.3-hr Activity of Terbium. Arnold Flammersfeld. Z. Naturforsch. 4a, 75-76 (1949) Apr. (Brief report, in German).

Terbium samples when irradiated with slow neutrons seem to give two activities with half-lives 3.3 - 3.9 hr and 73.5 day, respectively. By a careful analysis of the activity curves of terbium and dysprosium the author claims to have shown, however, that the so-called 3.3 - 3.9-hr activity of terbium is actually due to a contamination with dysprosium whose activities have half-lives of 2.4 hr and 1.25 min, respectively. The sample from which Seren et al (Phys. Rev. 72, 888(1947)) determined an apparent 3.3-hr activity of terbium would thus have had a 1.5% dysprosium contamination.

867 Disintegration of Helium by π^- Mesons. S. N. Ruddlesden and A. C. Clarke. Nature 164, 487-8 (1949) Sept 17 (Letter to the editor).

The energy spectra and relative probabilities of the three types of He^4-decay have been calculated on the following assumptions: the meson is captured from the lowest Bohr orbit; the whole mass (290 m_e) is converted into energy; the interaction energies are (a) ψ (r) or (b)$\sigma.\nabla\psi$(r), where ψ (r) is the scalar meson wave function at the position of a proton and σ is the spin operator of the proton. Gaussian wave functions $\exp(-\alpha\Sigma r_{ij}^2)$, $1/\sqrt{\alpha} = 4.0 \times 10^{-13}$ cm) are used for the nuclei and plane waves for the emitted particles. The transition probabilities are determined by the usual perturbation method. It was found that the relative probabilities for emission of a triton, deuteron or proton are 5:1:5 with interaction (a), or 12:1:25 with interaction (b). Only one energy (30 Mev) is possible for the triton if the meson is completely absorbed; but, if a neutral meson is formed, a spectrum of energies will be observed. The probability of deuteron emission is rather small and is reduced further if the value of α in the deuteron wave function is reduced (corresponding to large radius). The normalized energy spectra of the protons are shown: (a) using interaction ϕ (r); (b) using interaction $\sigma.\nabla\phi$(r); (c) using a matrix element independent of the energies of the emitted particles. It is noted that variation of the parameter α in the nuclear wave functions does not greatly affect the results.

868 Disintegration of I^{124} and I^{126}. Allan C. G. Mitchell, J. Y. Mei, Fred C. Maienschein, and Charles L. Peacock. Phys. Rev. 76, 1450-3(1949) Nov. 15.

The nuclear radiations from I^{124} (4 days) and I^{126} (13 days) have been measured. I^{124} decays to Te^{124} with the emission of three positron groups with end points at 2.20 $\pm$ 0.01, 1.50 $\pm$ 0.01, and 0.67 $\pm$ 0.05 Mev, possibly accompanied by some K-electron capture. Gamma rays of energy 0.603 $\pm$ 0.002, 0.73 $\pm$ 0.01, 1.72 $\pm$ 0.02, and 1.95 $\pm$ 0.05 are given off in the disintegration. I^{126} decays to Xe^{126} with the emission of two β-ray groups of energies 1.268 $\pm$ 0.010 and 0.85 $\pm$ 0.01 Mev, together with a γ ray of energy 0.395 $\pm$ 0.005 Mev. An active state of I, of 13.0 $\pm$ 0.5-hr half-life, which decays by K-capture and the emission of an internally converted γ ray of energy 0.159 Mev, has been found. This activity is assigned to I^{125}.

869 Disintegration of Ni^{65}. Kai Siegbahn and Amal Ghosh. Arkiv Mat. Astron. Fysik 36 A, No. 19 (1949). 11p. (See also NSA 3-1312.)

Investigations have been made of nickel which had been bombarded with 7-Mev deuterons in an attempt to determine the decay scheme of 2.6-hr Ni^{65}. The β spectrum, which was studied with a magnetic lens spectrometer, was found to be complex; the maximum energies of the endpoints, as determined by extrapolation of the Kurie-plots, were 2.10, 1.01, and 0.60 Mev, with relative intensities of 57, 14, and 29%,

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respectively. From the photoelectron spectrum and Compton-electron spectrum, γ energies were obtained at 0.37, 1.12, and 1.49 Mev with relative intensities of 10, 30, and 60%, respectively. Coincidence measurements indicated about 5.7×10^{-4} β-γ coincidence/β particle recorded and about 1.2×10^{-4} γ-γ coincidences/γ quantum recorded. A decay scheme based on these data is shown. In a letter to the editor (Phys. Rev. 76, 307(1949); NSA 3-1312) some theoretical implications of these experiments are discussed.

870 The disintegration Scheme of Tm^{170}. J.S. Fraser. Phys. Rev. 76, 1540-1(1949) Nov. 15 (Letter to the editor).

New evidence for the complexity of the β-ray spectrum of 127-day Tm^{170} was obtained by the use of a thin lens spectrometer supplemented by β-γ-coincidence measurements. The β-ray spectrum was shown to consist of two components; one with a maximum energy of (970 ± 5) kev as reported previously, and a second with an end point of (886 ± 5) kev comprising approximately 10% of the transitions. The single weak γ ray, (Seaborg and Perlman, Revs. Modern Phys. 20, 585(1948)) largely internally converted, was found to have an energy of (83.9 ± 0.2) kev. It was also found that the ratio of β-γ coincidences to β rays is very low. A decay scheme is proposed which is consistent with these experimental results.

871 The Electronic Radiation of Protactinium. Jean Teillac. Compt. rend. 229, 650-1(1949) Oct. 3 (in French).

The article deals with an experimental study of internal conversion electrons emitted by protactinium. Electronic radiation was observed in a Wilson cloud chamber; the experimental arrangement has been previously described (Compt. rend. 227, 1227(1948)). Nine hundred and twelve α tracks were observed in addition to 228 associated electron tracks. Ten of the electrons had energies higher than 100 kev. The other electron tracks fell into three energy groups as indicated in a plot of the energy spectrum. This spectrum gives some indication of a fine structure in the α radiation, previously reported (S. T. Tshen et al, J. phys. radium 7, 167(1946); Compt. rend. 226, 171(1948)). One of the groups appears to consist of L shell electrons as indicated by Meitner (Z. Physik 50, 15(1928)), but the others are of unknown origin.

872 Gamma-Ray of K^{40}. G.A. Sawyer and M. L. Wiedenbeck. Phys. Rev. 76, 1535(1949) Nov. 15 (Letter to the editor).

The γ-ray activity of K^{40} has been determined by means of a scintillation counter calibrated with a known activity of K^{42}. Four lb of KCl were placed around a crystal of stilbene and the light output was fed to two photo-multipliers in coincidence. The activity of the K^{40} was determined by adding quantities of K^{42} whose activities had previously been measured by β-ray counting. After correcting for the decay of K^{42}, the activity of K^{40} was found to be 3.6 ± 0.3 γ rays/g of ordinary potassium/sec, in good agreement with the values of Gleditsch and Graf (Phys. Rev. 72, 640(1947)).

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873 The Half-life Period of Rubidium 87. Maria Kemmerich. Z. Physik 126, 399-409(1949)(in German).

The half-life of the naturally radioactive Rb^{87} was determined from activity measurements. By sublimation, the inner surface of the wall of a Geiger-Mueller counter was covered with a 0.03 to 4 mg/cm^2 thick layer of RbCl. In this way, the soft component of Eklund (Arkiv Mat. Astron. Fysik 33 A, No. 14 (1946)) was isolated. By taking into account the internal conversion electrons, (Haxel and Houtermans, Z. Physik 124, 705(1948)), the half-life period of Rb^{87} was found to be equal to $(6.0 \pm 0.6).10^{10}$ yr.

874 Life-time for Pair Emission by Spherically Symmetrical Excited State of the O^{16} Nucleus. S. Devons, H. G. Hereward, and G. R. Lindsey. Nature 164, 586-7 (1949) Oct. 1 (Letter to the editor). (See also NSA 3-2333.)

Two series of experiments have been performed which have been related to the assumption of the existence of two states of the O^{16} nucleus previously made to explain certain experimental results (Nature 164, 539(1949)). First an attempt was made to establish an order of magnitude for the life-time by bombarding a fluorine target with a pulsed beam of protons (pulse duration of between 10^{-4} and 5×10^{-7} sec), detecting the electron-positron pairs from O^{16} nucleus (produced by the reaction $F^{19}(p.\alpha)O^{16}$) by means of Geiger counters, and investigating whether the emission of the electrons was simultaneous with bombardment of the fluorine target. The results indicated a life-time of less than 10^{-8} sec. In the second series of experiments a thin (3×10^{-5} g/cm^2) layer of calcium fluoride deposited on a plane solid surface was bombarded with protons. By a suitable arrangement of apertures, the only electrons and positrons detected were those which came from O^{16} nuclei which had moved more than a prescribed, but variable, distance from the plane of the target in the direction away from the solid backing material. From the work of Blackett and Lees (Proc. Roy. Soc. (London) 134 A, 658(1932)) on the ranges or recoiling nuclei, the small (about 10% on the average) reduction in velocity of the O^{16} nuclei in traversing part of the calcium fluoride layer was estimated. The mean distance travelled by the excited O^{16} nuclei between the instant of their formation and the emission of electron-positron pairs was estimated as 0.18 m; this corresponding to a mean life of 7×10^{-11} sec. The simplest way of relating this result to the properties of the two states of the O^{16} nucleus is to regard the nucleus in both states as a uniformly charged sphere, and uniformly dilated in the state of higher energy. An alternative model, representing approximations of an opposite kind, is the simple α-particle model in which the O^{16} nucleus is represented as four α particles at the vertices of a regular tetrahedron, and the excited state at 5.9 Mev associated with the first, spherically symmetrical vibrational mode of oscillation. The first (liquid-drop) model gives a value for the nuclear compressibility which is in better agreement with the values deduced from other data.

875 Instrumental Distortions in the Shapes of Continuous Beta-Spectra. George E. Owen and C. Sharp Cook. Rev. Sci. Instruments 20, 768-72(1949) Nov.

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The positron spectrum of Cu^{61} and the negatron spectrum of P^{32} have been studied in a 5.7-cm radius of curvature magnetic spectrometer using a variety of vacuum chamber sizes and baffle designs. Conclusions are drawn from these data concerning the distortions in continuous beta spectra caused by scattering from the finite geometry of the chamber.

876 Interference Effects in Gamma-Gamma Angular Correlations. Daniel S. Ling, Jr., and David L. Falkoff. Phys. Rev. 76, 1639-48(1949) Dec. 1.

The theory of the directional correlation of successive nuclear gamma rays is extended to include transitions in which mixtures of multipoles are present. For such cases interference effects can radically modify the angular correlation from what is predicted in the usual theory assuming pure multipole transitions. Correlation functions are tabulated for all possible cascade emissions in which one of the transitions is a mixture of magnetic dipole and electric quadrupole and the other either dipole or quadrupole. It is shown that the experimental data on Sr^{88} which had previously seemed anomalous can be consistently interpreted with the mixture theory developed here, but the agreement with the observed angular correlation in Pd^{106} is not possible if the highest γ-multipole order is assumed to be quadrupole.

877 Internal Conversion Coefficient and Mass Assignment of the 57-Min Se Isomer. I. Bergström and S. Thulin. Phys. Rev. 76, 1718(1949) Dec. 1 (Letter to the editor).

Selenium bombarded with deuterons was separated with an electromagnetic isotope separator, and carrier free activities were deposited on very thin foils. The 57-min activity at mass 81 was sufficient for a β spectrometer investigation. A spectrum of this activity is given, with an accuracy of 10%, from which the internal conversion coefficient for the γ ray corresponding to the transition $Se^{81*} \rightarrow Se^{81}$ was calculated. This calculation involved knowledge of the values of the half-lives of Se^{81} and Se^{81*}, given as 57 m and 19 m by A. Langsdorf, Jr., and E. Segrè (Phys. Rev. 57, 105(1940)) and as 56.5 m and 13.6 m by H. Wäffler and O. Hirzel (Helv. Phys. Acta 21, 200(1948)). The first pair of values gives an impossible internal conversion coefficient of 120%, the second pair gives 104%, which indicates that within the limit of experimental error the γ ray corresponding to the isomeric transition is almost completely converted.

878 Internal Pair Creation in Na^{24}. E. R. Rae. Phil. Mag. 40, 1155-8(1949) Nov.

A measurement has been made of the internal pair-creation coefficient of the 2.76-Mev γ-ray line from Na^{24}. This is found to lie very close to the curve of electric dipole transitions predicted by Jaeger and Hulme for $Z = 0$ and suggests that measurement of this coefficient for high energy transitions in light nuclei may provide a useful method of determining multipole order. On the assumption that the 2.76-Mev line is of dipole origin, an energy level diagram has been constructed for the Mg^{24} nucleus.

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879 K-Capture and Positron Emission of Cu^{61} and Cu^{64}. O. Huber, R. Rüetschi, and P. Scherrer. Helv. Phys. Acta 22, 375-8(1949) Aug. (in German).

In positron emitters a competing K-capture takes place, and the probability ratio $W_K/W^+ = w$ can be calculated with the aid of the Fermi theory. The experimental determination of w is difficult because it requires the absolute measurements of both processes. However, the ratio w'/w'' for two isotopes of an element can be readily determined. Thus, for Cu^{61} and Cu^{64}, Bradt et al, (Helv. Phys. Acta 18, 252(1945)) have found $w^{64}/w^{61} = 5.5 \pm 0.3$, whereas the Fermi theory gives the value 7.6. This discrepancy motivated the present work. The authors undertook the determination of w^{64} and w^{61} by measuring (1) the 7.5 kev Ni x rays due to the K-capture, with the aid of a foil counter, and (2) the number of positrons, by counting the 511-kev annihilation quanta. These absolute measurements necessitated the determination of the sensitivity of the counters by methods described in the paper. The results confirmed the discrepancy mentioned above; $w^{64} = 1.75 \pm 0.02$ (theory: 2.08); $w^{61} = 0.32 \pm 0.03$ (theory: 0.28); $w^{64}/w^{61} = 5.32 \pm 0.18$ (theory: 7.6).

880 Magnetic Multipole Internal Conversion. N. Tralli and I. S. Lowen. Phys. Rev. 76, 1541-2(1949) Nov. 15 (Letter to the editor).

In a previous letter (Phys. Rev. 75, 529(1949)) on the calculation of magnetic internal conversion coefficients in the Pauli approximation, curves of the ratio of the coefficients in the K shell to those in the L shell versus Z^2/E for $Z = 35$ and E the γ-ray energy in kev, were given for multipole orders $l = 1, 2, 3$. The calculations have been extended to cover multipole orders 4 and 5. The complete set of curves is reproduced. In another figure the ratio of the magnetic internal conversion coefficients for the L_{III} sub-shell to those of the L_I sub-shell is plotted against Z^2/E for $Z = 35$. The curves should be valid for low Z and E, but their accuracy and range of validity will not be known until exact calculations are carried out.

881 Measurement of the Energies of α-Particles. T. E. Cranshaw and J. A. Harvey. Can. J. Research 26 A, 243-54(1948) July.

The energies of the α particles from weak preparations of several new radioactive substances were measured in a grid ionization chamber filled with argon. The accurately known energies of α particles from several well known sources were used for calibration. The voltage pulses produced by electron collection from the tracks were amplified in a linear amplifier of high stability and converted into flat-topped pulses. An accurately known voltage was subtracted, and the small residual pulses were further amplified. The frequency distribution of pulse sizes was recorded on an electronic pulse analyzer. The final values of the energies are as follows: U^{233}, 4.823 ± 0.003; Ac^{225}, 5.801 ± 0.010; Fa^{221}, 6.298 ± 0.010; At^{217}, 7.023 ± 0.010; Po^{213}, 8.336 ± 0.005; and Pu^{239}, 5.159 ± 0.005. The ionization-energy curve in argon was found to be linear within experimental error for α particles of energies 5 to 9 Mev. Extrapolation of this line determines an intercept of 85 kev at zero ionization. 15 references.

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882 Measurement of the Half-Period of Polonium 213. J. V. Jelley. Can. J. Research 26 A, 255-67(1949) July.

In the recently discovered (4n + 1) radioactive series, Bi^{213} transforms to Po^{213} by β emission. The latter rapidly transforms by α emission to Pb^{209}. The present paper describes a measurement of the half-period of Po^{213}. A preparation of Ra^{225} was placed between two Geiger-Mueller counters. One detected β particles while the other detected α and β particles. Coincidences were counted with a modified Rossi circuit. The pulse-width on the grid of one of the tubes of the coincidence unit was made variable while the pulse-width on the other remained fixed and the pulse-width associated with the counter that responded only to β particles was chosen to be variable. Coincidences were counted as a function of the pulse-width and corrections were made for accidental coincidences and exact coincidences arising from other causes. The final value for the half-period T of Po^{213} is T = 4.2 ± 0.8 μsec. A subsidiary experiment to determine the half-period of thorium C′ gave the value T = 0.34 ± 0.06 μsec in reasonable agreement with measurements by other workers.

883 A Metastable State of Half-life 13×10^{-9} Sec. in $_{71}Lu^{177}$. F. K. McGowan. Phys. Rev. 76, 1730-1 (1949) Dec. 1 (Letter to the editor).

A delayed scintillation spectrometer was used to investigate the radiation spectrum resulting from the isomeric transition of Lu^{177*}. For this purpose anthracene crystals and type 5819 multiplier tubes operated at room temperature were used with a delayed coincidence unit described previously (McGowan et al, Phys. Rev. 75, 1761(1949)). A differential pulse height selector was used in the channel for detection of delayed radiation. By counting coincidences in a small height interval against pulse height a measurement of the spectrum of the delayed radiation was obtained. It appears that the disintegration of Yb^{177} (with a half-life of 18 ± 0.1 hr) leads to a metastable state of Lu^{177*} which in turn decays to the ground state with a half-life of $(13 \pm 2) \times 10^{-9}$ sec.

884 On the Activities at Various Depths in Silver Irradiated with Deuterons. Catherine Chamié, Henriette Faraggi, and Branca Marques. Compt. rend. 229, 358-60(1949) Aug. 1 (in French).

Previous studies (Compt. rend. 228, 1289(1949)) of the activities of layers at various depths in a metal whose surface has undergone deuteron bombardment have been continued. Ten 0.02-mm layers of silver, arranged in a stack, were bombarded in a vacuum with 6.5-Mev deuterons. It has been verified that the form of the decay curves of the activity changes with depth and that certain layers contain intensity maxima. Such curves, which were obtained with a thin (3 mg/cm^2) window mica counter, are shown for three layers. It is noted that: (1) in the successive layers the activities produced by the deuterons differed from that observed in a single thin layer; and (2) layers situated beyond the deuteron range were noticeably active. The presence of secondary radiations (p, n, H^3, and He^3) is suggested to account for the phenomena observed.

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885 On the Photoelectron Spectrum of Ta^{182}. C. Harold Goddard and C. Sharp Cook. Phys. Rev. 76, 1419-20 (1949) Nov. 1. (Letter to the editor).

The photoelectron spectrum of Ta^{182} was investigated with the aid of a 14-cm radius of curvature uniform field spectrometer. Eight γ ray energies were found in the region below 330 kev, which correspond to the γ-ray energies determined by Cork et al (Phys. Rev. 75, 1778(1949)). Three higher energy gammas are also reported; the observed spectrum is plotted and all γ energies are tabulated. The results are not in complete agreement with those of Wilkinson, Beach, and Peacock (Indiana University Third Annual Report on Contract N6ori-48, Task Order I (Aug. 1, 1949)).

886 On the "Positive Tracks" on Wilson Photo's. J. H. Spaa and G. J. Sizoo. Physica 15, 316-26(1949) May.

The emission of positive particles by a UX source has been investigated by means of a spectrometer and a 30-cm cloud chamber. From the negative result obtained it was concluded that the number of positive tracks is at least ten times smaller than the value determined in earlier experiments in which no collimation was used. A negative result was also obtained in an experiment in which an aluminum foil was bombarded by electrons having energies of approximately 1.2 Mev, in order to check the validity of the abnormally high pair-production rate suggested by previous experiments. 20 references.

887 On the Preparation and Radiation of U^{237}. Lars Melander and Hilding Slätis. Arkiv Mat. Astron. Fysik 36 A, No. 15 (1949) 9p.

Results, which have been reported elsewhere (Phys. Rev. 74, 709-711(1948), NSA 1-1372), are discussed in greater detail.

888 On the Shape of the Positron Spectrum of Cu^{61}. George E. Owen and C. Sharp Cook. Phys. Rev. 76, 1536-7(1949) Nov. 15 (Letter to the editor).

There is some experimental evidence (Cook and Langer, Phys. Rev. 73, 601(1948); 74, 227(1948)) of an excess of low energy particles in the spectrum of β emitters, as compared with the theoretical spectrum predicted by the Fermi theory. This excess has been attributed to the thickness of the sources used. In this experiment Cu^{61} was prepared by a (d,2n) reaction on Ni^{61} and the copper electroplated onto a tungsten wire. It was then evaporated onto an aluminum foil, and the layer formed was less than one atomic diameter in thickness. F-K plots with and without the shielding correction of Rose (Phys. Rev. 49, 727(1936)) are given and it is seen the low energy excess is still in evidence.

889 Origin of Low-Energy Electron Lines in the β-Spectrum of ^{198}Au. B. V. Thosar. Proc. Phys. Soc. (London) 62A, 739(1949) Nov. 1 (Letter to the editor).

The low-energy part of the β spectrum of Au^{198} was investigated, using the 254°-radial electrostatic field spectroscope. Several samples made from pure precipitated gold and also from gold foil were irradiated in the Harwell pile. It was found in all cases that two fairly intense conversion electron

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lines appear in the spectrum, one at energy 44 kev and the other at 58 kev. Interpreted as due to internal conversion in gold in K and L shells, respectively, they would correspond to γ-ray energies of 0.125 Mev and 0.072 Mev. The intensity of these lines was observed over five days and the half-life was found to be of the order of three days. A long strip of gold foil, made into a small tight roll, was then irradiated at Harwell, so that the inner portion of the coil would be shielded from resonance neutrons, which produce the Au^{198} activity. Measurements of the α activity and of the activity due to several conversion electron lines, made on both the shielded and unshielded sections of the foil, indicate that the conversion electron activity is caused by fast neutrons acting on Au^{197}, and that it is not part of the Au^{198} activity.

890 Particle Groups from the Alpha-Particle Bombardment of Boron. Robert J. Creagan. Phys. Rev. 76, 1769-73(1949) Dec. 15.

Targets of natural boron and targets of 96% B^{10} have been bombarded by 7.45-Mev and 6.64-Mev cyclotron alphas. Seven charged particle groups have been observed. The Q-values calculated from the energy of the various groups have been assigned as follows: Q_1 = 4.07 Mev to the $B^{10}(\alpha,p)C^{13}$ reaction; Q_2 = 0.85 Mev to the $B^{11}(\alpha,p)C^{14}$ reaction; Q_3 = 0.31 Mev to the first excited state of carbon 13 at 3.76 Mev. Other values are: Q_4 = 0.07 Mev; Q_5 = −0.31 Mev; Q_6 = −1.57 Mev; Q_7 = −1.76 Mev with assignments discussed. The assignments were checked with B^{10} targets and proton-gamma-coincidence technique. Gammas were detected by coincident counts from two photo-multiplier tubes observing the same naphthalene crystal. Excited states of carbon 13 were searched for, but not observed, at 0.8 Mev and 3.12 Mev. 12 references.

891 Positive Particles Associated with Beta-ray Emitters. K. L. Erdman, G. T. Kokotailo, and D. B. Scott. Phys. Rev. 76, 1262(1949) Oct. 15 (Letter to the editor).

A search has been made for the positive particles reported to accompany the decay of certain β-ray sources (Bradt et al, Helv. Phys. Acta 16, 491(1943); Smith and Groetzinger, Phys. Rev. 70, 96(1946)). A 9-in. cloud chamber filled with air at atmospheric pressure was used. Stereoscopic photographs of S^{35}, UX (Th^{234}, Pa^{234}) Ra(D+E) (Pb^{210}, Bi^{210}), and P^{32} sources were taken and a 34-mg/cm^2 Pb foil was stretched across the chamber 10 cm from the source. Tabulated results are given which were obtained using collimated sources of the aforementioned materials. From these it is concluded that the positive particles which have been reported are one of the following: (a) electrons which have been reflected back to the source, (b) electrons whose tracks are nearly closed circles, part of the track being out of the illumination or obscured by other tracks, or (c) electrons of low energy with "positive" curvature due to scattering. From the results of these experiments it seems unnecessary to propose either the existence of positive particles of lighter mass than the electron (Bradt et al, Helv. Phys. Acta 16, 491(1943)) or positive particles of greater mass than the electron (Groetzinger et al, Phys. Rev. 75, 342(1949)).

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892 The Positron and Negatron Spectra of Cu^{64}. George E. Owen and C. Sharp Cook. Phys. Rev. 76, 1726-7 (1949) Dec. 1 (Letter to the editor).

A source of Cu^{64} was prepared by the process $Zn^{64}(n,p)Cu^{64}$, which contained only radioactive copper atoms and had a thickness of 10^{-4} μg/cm^2. The β-ray spectra were measured by means of a spectrometer with a radius of curvature of 6-cm. The Fermi-Kurie plot of both the positrons and negatrons turned out to be linear down to less than 50 kev. It is suggested that previous deviation found in the Fermi-Kurie plot of Cu^{64} were due to finite source thickness.

893 A Possible Standard for Radioiodine. A. H. W. Aten, Jr. Science 110, 394-5(1949) Oct. 14.

It is noted that the absorption of Cl^{36} β particles which have passed through 125 mg/cm^2 of Al coincides almost exactly with the absorption of the unfiltered β radiation of I^{131}. This suggests the use of such a preparation as a radio-iodine standard. Since only weak γ rays are emitted by Cl^{36}, there is no objection to the reduction of the intensity caused by this filtering. Tabulated data are given for different types of counters on the ratio of the number of counts/min obtained using the Cl^{36} source and filter to the number obtained using I^{131}; excellent agreement was obtained using mica-window counters. It is noted that the standard should not be used at a distance which is much less than half the diameter of the counter's sensitive surface.

894 Precision Wave-Length Measurements of the 1.1- and 1.3-Mev Lines of Co^{60} with the Two-Meter Focusing Curved-Crystal Spectrometer. David A. Lind, J. R. Brown, and Jesse W. M. DuMond. Phys. Rev. 76, 1838-43(1949) Dec. 15.

Recent improvements in the two-meter focusing curved-crystal γ-ray spectrometer are described which have extended its quantum energy range well above 1 Mev and have also yielded much better luminosity and resolving power than were obtained initially. The improved components are (1) the crystal holder whose aperture and resolving power have been nearly doubled and (2) the collimator the new model of which can now discriminate between the reflected and transmitted beams when these differ in direction by only 8 min of arc, a threefold improvement over the first model. Plans for further possible improvements and the factors governing these are also discussed. Wavelengths of two γ rays emitted following β decay of Co^{60} have been measured with this new equipment using a source of about 50 mc strength and found to have values of $(9.308 \pm 0.005) \times 10^{-11}$ cm and $(10.580 \pm 0.005) \times 10^{-11}$ cm corresponding to quantum energies of 1.3316 ± 0.0010 Mev and 1.1715 ± 0.0010 Mev, respectively. The lines appear to have equal intensities. The integrated reflection coefficient of the (3 1 0) planes of the curved-quartz crystal still appears to follow a λ^2-dependence on wavelength down to 9 x.u., the shortest so far observed.

895 Probability of the Formation of Monochromatic Positrons of Internal Conversion. L.A. Sliv. Doklady Akad. Nauk. S. S. S. R. 64, 321-3(1949)(in Russian).

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Latyshev et al (Doklady Akad. Nauk. S.S.S.R. 63, No. 5 (1948)), in studying the positron spectrum of internal conversion of RaC ',(Po^{214}), have found, in various places of the spectrum, certain narrow maxima, whose origin may be explained in the following way. A pair is formed as a result of a transition of the nucleus from an excited state to a lower level; if, at this time, one of the orbits of the electronic shell is free, the electron of the pair will occupy the orbit, and the positron will leave the atom with the rest of the pair's energy; a discrete positron spectrum will be observed, corresponding to the formation of those pairs in which the electrons have the energy of the levels K, L, M, etc; this discrete positron spectrum will occupy a region beyond that of the continuous spectrum, and the line corresponding to K will be the farthest one. The probability of the formation of such monochromatic positrons of internal conversion is given. It is shown that the study of their properties furnishes means for an estimate of the width of nuclear levels, and for an analysis of cascade-like transitions.

896 The Radiations of Tantalum^{182}, Rhenium^{186,188}, and Gold^{199}. Louis A. Beach, Charles L. Peacock, and Roger G. Wilkinson. Phys. Rev. 76, 1585-91(1949) Dec. 1.

A survey of the radiations of Ta^{182}, $Re^{186,188}$ and Au^{199} has been made down to energies of the order of 5 kev with a small 180-deg. spectrometer. The disintegration scheme of Ta^{182} is complex. The 20 or more conversion lines found superimposed on the β-ray spectrum and the numerous peaks found in the photoelectron spectrum are analyzed into 17 gammas in the energy region 80 to 330 kev. In addition, 3 γ rays of energies 1.13, 1.22, and 1.24 Mev are found. The continuous spectrum has an end point at 0.53 Mev. The radiations of Re^{186} consist of a single β-ray group of maximum energy 1.07 Mev and two γ rays of energies 0.138 and 0.212 Mev. The 0.138 Mev γ ray is converted. Coincidence experiments strongly suggest that the mode of decay is one involving the emission of a single β-ray group, followed by the cascade emission of the two γ rays. The disintegration of Re^{188} is more complicated. A single group of β rays is found with the end point at 2.10 Mev. Five γ rays with energies essentially the same as those reported by Miller and Curtiss (Phys. Rev. 70, 983(1946)) are present. All the radiations of Au^{199} lie below 0.32 Mev. Superimposed on the β-ray spectrum are eight conversion lines that may be attributed to 4 γ rays having energies of 0.024, 0.051, 0.156, and 0.207 Mev. The β rays have a maximum energy of 0.32 Mev. A possible decay scheme is suggested.

897 Radiation from Zn^{65}. K. C. Mann, D. Rankin, and P. N. Daykin. Phys. Rev. 76, 1719-20(1949) Dec. 1 (Letter to the editor).

Preliminary results are reported of measurements of the β and γ radiations from Zn^{65}. The β spectrum was measured by means of a thin lens type magnetic spectrometer, the γ spectrum by means of a uranium radiator of density 50 mg/cm^2 from which photoelectrons were expelled by the γ rays and their energy measured. It was found probable by the authors that orbital electron capture and positron emission are the only modes of decay of Zn^{65}. Extrapolation of the positron spectrum leads to an end point of 0.325 ± 0.002 Mev. The maximum energy of the Compton electrons found was 1.17 Mev, which corresponds to a γ ray of 1.38 ± 0.03 Mev.

898 The Radiation Spectra of Barium^{140} and Lanthanum^{140}. Louis A. Beach, Charles L. Peacock, and Roger G. Wilkinson. Phys. Rev. 76, 1624-8(1949) Dec. 1.

The radiations of Ba^{140} and La^{140} have been measured with a small 180-deg. spectrometer. For the case of Ba^{140} three γ rays are present, all of which are converted, with energies 0.16, 0.31, and 0.54 Mev. The β-ray spectrum shows the presence of two groups with maximum energies of 0.48 (40%) and 1.022 (60%) Mev. The radiations of La^{140} are complex. Six γ rays of energies 0.093?, 0.335, 0.49, 0.82, 1.60, and 2.5 Mev are present, the first three being internally converted. The β-ray spectrum is resolved into three groups with end points at 1.32 (70%), 1.67 (20%), and 2.26 (10%) Mev. Decay schemes for these isotopes are suggested.

899 Radioactive In^{107}, In^{108}, In^{109}, and Sn^{108}. E. C. Mallary and M. L. Pool. Phys. Rev. 76, 1454-7(1949) Nov. 15.

A new indium isotope which decayed with a 33 ± 2-min half-life has been produced by deuteron and proton bombardments of Cd^{106}. Evidence for the assignment of the activity to In^{107} is given. Characteristic radiations are positrons of 2-Mev energy and γ rays. An indium isotope which decayed with a 4.30 ± 0.15-hr half-life has been produced by a deuteron and proton bombardment of Cd^{108} and by an α bombardment of Cd^{106}. The assignment is made to In^{109}. Decay is by emission of 0.75 ± 0.05-Mev positrons, by K-electron capture, and by emission of γ rays. Two genetically related isotopes in tin and indium have been assigned to mass number 108. The tin isotope, which is produced by bombarding Cd^{106} with α particles, decays with a half-life of 4.5 hr by K-electron capture. The indium isotope, which is produced by the decay of the tin isotope and by bombarding Cd^{106} with deuterons, decays with a half-life of about 55 min by emitting positrons of 2-Mev energy and γ rays.

900 Radioactive Y^{84}, Y^{88}, and Zr^{87}. B. E. Robertson, W. E. Scott, and M. L. Pool. Phys. Rev. 76, 1649-50 (1949) Dec. 1.

A 3.7-hr activity, assigned to Y^{84}, has been obtained by bombardment of Sr^{84} with 10-Mev deuterons. Characteristic radiations are 2.0-Mev positrons, x-rays, and γ rays. A 2.0-hr activity, assigned to Zr^{87}, has been obtained by bombarding natural strontium and Sr^{84} with 20-Mev α particles. Characteristic radiations are 2.0-Mev positrons, x-rays, and γ rays. Bombardments of Sr^{87} + d, Y + n[f], and Rb + α are in agreement with the assignment of a 105-day activity to Y^{88} but show no evidence of a 2.0-hr positron activity previously assigned to Y^{88}.

901 The Ratio of L_1 and K Capture. M. E. Rose and J. L. Jackson. Phys. Rev. 76, 1540(1949) Nov. 15 (Letter to the editor).

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The phenomenon of orbital electron capture from the L_1 shell was observed by Pontecorvo, Kirkwood, and Hanna (Phys. Rev. 75, 982(1949)) in A^{37}. The experimental value of the ratio of probabilities for L_1 to K capture was reported to be between 8 and 9%. A computed ratio of only 6% is obtained using relativistic wave functions with Slater screening constants (Marshak, Phys. Rev. 61, 431(1942)). Using a better representation of the screening, better agreement with experiment may be attained. The calculations were carried out, first, using relativistic wave functions computed on the Eniac by Reitz with a potential derived from a Thomas-Fermi field and, second, with self consistent field functions. In the first case the computed ratio was 8.2% and in the second 8.1%. The computed ratio for other values of Z may be obtained from a graph included in the article.

902 The Role of the Electronic Gonfiguration in the Phenomena of Radioactivity. Raymond Daudel and Maurice Jean. Compt. rend. 229, 354-6(1949) Aug. 1 (in French).

The various possible effects that the electronic configuration surrounding a nucleus can have on a radioactive decay, in particular with respect to internal conversion and the state in which the particle is left (i.e., neutral or ionized, excited state or ground state), are considered. The probabilities of the various alternatives are discussed briefly for β^- and β^+ decay. It is noted that studies are now in progress on the effects of an increase in the potential energy of the configuration, following radioactive decay, upon its arrangement.

903 Selection Rules for the β Decay. B. S. Dzhelepov. Doklady Akad. Nauk. S. S. S. R. 65, 149-50(1949) (in Russian).

According to accepted theories, the variation of the mechanical moment and the symmetry of the initial and final wave functions determine whether a β disintegration is allowed or forbidden. The application of these criteria is difficult, because, as a rule, the above magnitudes are unknown for radioactive nuclei. The usual procedure is to revert to tables of the τf values. It is from the study of such tables that the author derived the following criterion: a β decay is allowed if it does not involve a rebuilding of the nucleus, $(X = 0)$; a β decay is forbidden, if such a rebuilding takes place, $(X \neq 0)$. The energy of the rebuilding X is equal to $E - E_k - E_m$, where E is the energy of the β disintegration, E_k is the change in the coulomb energy, and $E_m = \pm (n-p)$ is the change in the mass. An important consequence is that all β^- decays, except $H^3 \rightarrow He^3$, are forbidden, since in these cases the increase of E_k is not compensated by the absolute value of n-p. The physical meaning of the new criterion resides in the fact that, whatever the changes in the spin and the symmetry, any rebuilding of the nucleus strongly modifies the wave function of the system and, consequently, lowers the matrix element of the disintegration.

904 The Sm^{151} Beta-Ray Spectrum. B. H. Ketelle and G. W. Parker. Phys. Rev. 76, 1416-17(1949) Nov. 1. (Letter to the editor).

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The source of β rays used for the spectrum analysis was fission product samarium, separated from other fission products by a method described elsewhere (Parker and Latz, AECD-2160). A layer of SmCl 1 mg/cm² thick was used in the experiment, and the spectrum was obtained with equipment similar to that described by Deutsch et al (Rev. Sci. Instruments 15, 178(1944)). Two high energy components appeared in the Kurie plot. These were attributed to Eu^{155} and a corrected plot is given. The β ray end point is at 79 kev, but the thickness of the source and the cut-off of the counter window distort the shape of the spectrum curve.

905 Some More Lower Limits of Half-lives for α-Decay. F. Bestenreiner and E. Broda. Nature 164, 919-20 (1949) Nov. 26 (Letter to the editor).

Lower limits for the α ray half-lives of the following elements were determined: Ti, Zn, Sr, Cs, Pr, Th, and Sm+Nd. The method used is one that has already been described (Cuer and Lattes, Nature 158, 197(1946); Jenkner and Broda, ibid 164, 412(1949); Bestenreiner and Broda, ibid 164, 658(1949)). It consists essentially of counting the number of α tracks in a photographic emulsion which has been loaded with the element in question. Previous measurements of the α activity of the element 61 in minerals were found to be incorrect, and a corrected value is given.

906 Study of the Radioactivity of Samarium by the Photographic Method. Edgard Picciotto. Compt. rend. 229, 117-19(1949) July 11 (in French).

No agreement is reached as to the radioactive properties of Sm, such as the range in air, the half-life, and the possible existence of a second group of emitted particles. A list of 23 references on the radioactivity of Sm is given. The author applied the photographic method to the study of the last two questions. Ilford C_2 plates, 50 and 100 μ, were immersed for 30 to 45 min into 0.2% to 0.4% solutions of $Sm_2(SO_4)_3.8H_2O$. No long-range α tracks were found among the 5,000 particles examined. The mean range in the emulsion is 7.04 ± 0.03 μ; this seems to be the only emission of the radioactive Sm. For the determination of the half-life period the author used the technique of double emulsions described by him in Compt. rend. 228, 2020(1949). Double emulsions ($50 + 50$ μ and $100 + 50$ μ) were prepared from two solutions (0.236 and 0.254%) of $Sm_2(SO_4)_3.8H_2O$. The exposition time varied from 4 to 20 days. The result obtained was 133 ± 6 α particles/g sec, corresponding to a half-life period $(6.7 \pm 0.4) \times 10^{11}$ years.

907 Theory of the Lithium Two-Alpha-Reactions. II. Angular Distribution of $Li^6(d,\alpha)\alpha$. Robert Resnick and D. R. Inglis. Phys. Rev. 76, 1318-23(1949) Nov. 1.

An analysis is presented of the variation of the intensity of alphas from $Li^6(d,\alpha)\alpha$ with angle and energy. This variation has been observed to have the form $1 + A(E)\cos^2\theta + B(E)\cos^4\theta$, just as in the case of $Li^7(p,\alpha)\alpha$ for which an analysis has already been given. For $Li^6(d,\alpha)\alpha$ it is again the Bose statistics and consequent even parity of the alphas that makes analysis possible. It is assumed that Li^6 has even parity, so that only s,d,$\cdots$ deuterons are relevant here, in contrast to Li^7

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$(p,\alpha)\alpha$ in which p,f,··· protons are involved. The two analyses differ also in the spin combinations, but are similar in the assumption of only two contributing states of the compound nucleus, with angular momentum quantum numbers 0 and 2. An expression for the energy variation of the angular distribution in $Li^6(d,\alpha)\alpha$ is derived from the dispersion formula and the treatment with two sharp levels is compared with that for one sharp and one broad level. The latter is found simpler and adequate for obtaining agreement with the experimental A(E) and B(E). After recognizing limitations on the parameters consistent with order-of-magnitude estimates of the matrix elements involved, it is found that the theoretical formulas rather naturally give the general form of the experimental results, including the feature that both A(E) and B(E) rise more slowly in the $Li^6(d,\alpha)\alpha$ reaction than in the $Li^7(p,\alpha)\alpha$ reaction as the bombarding energy is increased from zero, a consequence of the spherical symmetry of the entering s waves which participate in the Li^6 reaction only.

908 28.7-hour Ba^{135}. B. E. Robertson and M. L. Pool. Phys. Rev. 76, 1408-9(1949) Nov. 1 (Letter to the editor).

The previously reported (Kalbfell and Cooley, Phys. Rev. 58, 91(1940)) 28.7-hr activity of barium has been investigated using electromagnetically enriched Ba^{132}, Ba^{134}, Ba^{135} and Ba^{136} in order to confirm the assignment of this activity to Ba^{135} (Yu and Kurbatov, Phys. Rev. 74, 34(1948)). The bombardment with 10-Mev deuterons resulted in specific intensities (in terms of the time-off intensity of the 28.7-hr activity) of the 28.7-hr activity per mg of bombarded barium in the ratios 1.00:0.73:0.54:0.03:0.05 for barium nitrates enriched in Ba^{134}, Ba^{132}, Ba^{135} and Ba^{136}, and natural barium, respectively. Similar bombardments of the enriched barium isotopes in carbonate form with fast neutrons from Li^+d produced the 28.7-hr activity with specific activities in the ratios 1.00:0.42:0.42:0.09:0.04 for the samples enriched in Ba^{135}, Ba^{132}, Ba^{134} and Ba^{136}, and natural barium. Bombardments of Hilger CsCl with 10-Mev deuterons and 20-Mev α particles also confirmed the assignment of the 28.7-hr activity to an isomeric state of Ba^{135} produced by the reactions $Ba^{134}(d,p)$ and $Ba^{135}(n^f,n)$. Calculations of the cross sections of the reactions will be published.

909 Upper Limit for the Lifetime of the 411-Kev Excited State of Hg^{198}. R. E. Bell and H. E. Petch. Phys. Rev. 76, 1409-10(1949) Nov. 1 (Letter to the editor).

The β-γ coincidences arising from the Au^{198}-Hg^{198} β disintegration have been examined with a short resolving time coincidence circuit in an effort to measure the mean life of the 411-kev γ-emitting state of Hg^{198}. The mean life is found too short to measure, in contradiction to MacIntyre's recent result (Phys. Rev. 76, 312(1949)). Scintillation counters without amplifiers detected the radiation. Resolution curves for the coincidence circuits are given along with a complete description of the apparatus. The upper limit for the lifetime is determined from a plot of the β pulse delay portion of the Au^{198} resolution curve, which indicates that the mean life is less than 3×10^{-9} sec. Upper limits for the lifetime of Ni^{60} and Ba^{134} are also given as incidental results.

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910 Bibliography: Propagation and Scattering of Electromagnetic Waves. Thelma Braverman and Jerome Lurye. Washington Square College New York University. Sept. 30, 1948. 54p. (NP-1076).

This bibliography, which covers the period from 1920 to Aug. 1948, is restricted to theoretical articles employing the methods of classical mechanics. Topics covered are propagation in media (homogeneous and nonhomogeneous), reflection and refraction from obstacles, diffraction around obstacles, and some general diffraction studies. A few papers on sound propagation related to electromagnetic theory are included.

911 Bosons in an Electromagnetic Field. R. G. Moorhouse. Phys. Rev. 76, 1691-6(1949) Dec. 1.

The interaction representation for bosons of spin 0 or 1 in an electromagnetic field is given, using β-matrix theory. The gauge invariance of the scheme is proved. The photon self-energy is shown to be zero, and the meson self-energy is evaluated. The vacuum polarization is evaluated for a particular representation of the β-matrices.

912 Energy Bands and Wave Functions in Periodic Potentials. Hubert M. James. Phys. Rev. 76, 1602-10 (1949) Dec. 1.

In preparation for treatment of the one-dimensional wave equation with perturbed periodic potentials, this paper discusses the case of perfectly periodic potentials. Solutions for the entire range of x are constructed by joining together "cell solutions" — solutions defined for a single period of the potential. Several types of cell solutions are discussed. The concept of "self-matching cell solutions" leads to a simple demonstration of the band structure of permitted energy levels. The effective momentum of the particle is defined for energies in the forbidden bands, and a parameter σ (E) of interest in the treatment of perturbed periodic systems is introduced. Expansions are given for solutions of the wave equation near the band edges, in both the permitted and forbidden bands.

913 The Equation of Motion and the Tensor of Matter of a System of Finite Masses, in the General Relativity Theory. N. M. Petrova. Zhur. Eksptl. i Teoret. Fiz. 19, 989-99(1949)(in Russian).

By using an approximation method given by Fok (Zhur. Eksptl. i Teoret Fiz. 9, 375(1939)), the calculation is made of the small corrections in Newton's equations of motion which are required by the general relativity theory. Simultaneously, the tensor of matter for the interior of bodies is derived in the second approximation.

914 Interaction Between the Electron and the Positron. V. B. Berestetskiĭ and L. D. Landau. Zhur. Eksptl. i Teoret. Fiz. 19, 673-9(1949)(in Russian).

In classical electrodynamics a system of interacting charges can be described with an approximation up to, and including, members of the order v^2/c^2, (v is the velocity of the charge), with the aid of a Hamiltonian function depending on the coor-

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dinates and the momenta of the particles and including no radiation field. In quantum mechanics, the Hamiltonian of a system of electrons, with the approximation v^2/c^2, has been given by Breit (Phys. Rev. 34, 553(1929)). The present author derives the wave equation of the system electron-positron, with the above approximation, the main problem being the description of the exchange interaction between the two particles.

915 On the Approach to Statistical Equilibrium. Arnold J. F. Siegert. Phys. Rev. 76, 1708-14(1949) Dec. 1.
The author considers as a random process the distribution of a gas in momentum space as function of the time. The probability of changes of the distribution in infinitesimal time intervals is assumed to be given by the "Stosszahlansatz." For the Rayleigh model of a gas the probability of a distribution as a function of the time is derived. For the Boltzmann gas with microscopic reversibility it is shown that the probability of a distribution approaches the stationary value in the limit of infinite time.

916 On Circular Orbits in Einstein's Gravitation Theory. S. A. Kaplan. Zhur. Eksptl. i Teoret. Fiz. 19, 951-2 (1949)(Letter to the editor, in Russian).
Einstein (Ann. Math. 40, 4(1939)) and Oppenheimer (Phys. Rev. 55, 374(1939)) have found that for certain physical configurations in Einstein's gravitational field there exists a limiting value of the radius, below which the configurations are unstable. The present author shows that this property is shared by circular orbits. The mimimum radius of stable orbits is $r = 6m$, where m is the mass of the central body and the units are those of the relativistic graviation theory, (the gravitational constant $G = 1$, $c = 1$); on this orbit, the energy E of the revolving body has a minimal value, equal to $m_1 \left(\frac{8}{9}\right)^{1/2}$, where m_1 is the mass of the revolving body, ($m_1 \ll m$).

917 On the Interactions of Mesons with the Electromagnetic Field. M. Neuman and W. H. Furry. Phys. Rev. 76, 1677-90(1949) Dec. 1.
By means of the formalism of Duffin and Kemmer (Phys. Rev. 54, 905(1938); Proc. Roy. Soc. (London) 173, 97(1939)) there is constructed for mesons interacting with the electromagnetic field a theory that is manifestly Lorentz invariant and also gauge invariant and invariant under charge conjugation. The transformation to an interaction representation is accomplished by a procedure necessarily somewhat more complicated than that used by Schwinger (Phys. Rev. 74, 1439 (1948)) for the quantum electrodynamics of electrons. The longitudinal components of the electromagnetic field are eliminated in a covariant manner. The resulting interaction Hamiltonian is analyzed into terms corresponding to self-energies and terms describing interactions. By a suitable interpretation of ambiguous expressions, the photon self-energy is shown to vanish. Expressions are found for the polarization of the mesic vacuum by a given electromagnetic field. In the case of mesons of spin 1, not only the term proportional to the original current, but also that proportional

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to its d'Alembertian has an infinite factor. A formal procedure for the unambiguous exclusion of such infinite contributions is suggested. Explicit expressions are found for the self-energies of scalar and vector mesons. These self-energies can be eliminated by renormalization of mass.

918 On the Theory of Age-Dependent Stochastic Branching Processes. Richard Bellman and Theodore E. Harris. Natl. Acad. Sci. U.S. 34, 601-4(1948) Dec.
A mathematical problem of interest in nuclear physics as well as in other scientific fields is investigated. Under the hypotheses that any particle has a life-length independent of its time of birth and the number of other particles existing at the time, and that there is no death, the probability distribution of Z(t), the number of particles in existence at time t, is obtained. A particle existing at the time $t_1 = 0$ is assumed to have a probability q_n, $n \geq 1$, of being transformed into n similar particles at some time $t > 0$.

919 The Radiation Principle. A. N. Tikhonov and A. A. Samarskiĭ. Zhur. Eksptl. i Teoret. Fiz. 18, 243-8 (1948)(in Russian).
A general radiation principle is formulated for the wave equation $\Delta v + k^2 v = -F(M)$, where $M = (x,y,z)$; solutions satisfying that principle are limiting solutions, at $t \to -\infty$, of Cauchy's problem in which the initial conditions of $u(M,t)$ are $u(M,0) = 0$ and $\frac{\partial u}{\partial t}(M,0) = 0$, and u is the variable in the vibration equation corresponding to the above wave equation. It is shown that, in an unlimited space, the method outlined here leads to solutions satisfying the known condition of radiation of Sommerfeld (Jahresber. deutschen mat. Vereinigung 21, 309(1912)).

920 Remarks on the Problem of the Vacuum Polarization and the Photon-Self-Energy. Res Jost and Jerzy Rayski. Helv. Phys. Acta 22, 457-66(1949).
The introduction of additional charged fields is sufficient to secure the gauge invariance of the vacuum polarization current and to yield a value zero for the photon self energy. On the other hand there remains the difficulty with the charge renormalization in an external field. This result contributes to the notion that the problems of the self charge is quite different from the problem of the self energy, and the analogy between the procedures of mass and charge renormalizations may be more or less superficial.

921 Singularity-free Solutions of the Schwarzschield-Nordström Type for a Point Charge, (Classical Electron Theory). M. F. Shirokov. Zhur. Eksptl. i Teoret. Fiz. 18, 236-42(1948)(in Russian).
It is shown that, for a point charge e_0, Einstein's gravitation equations and those of the electromagnetic field have a general solution containing an arbitrary function μ (r), which, through a convenient choice of that function, describe gravitational and electromagnetic fields, free from singularities

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in all the range of r from zero to infinity. For a certain μ (r), the result is the singularity-free solution of Einstein and Rosen for a neutral particle of mass m. For the electron, the function μ is chosen among $\mu = -2\log(1-e^{-kr})$, with a constant $k = 1/r_0$. The solution is a regular one, leading, in the

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calculation of the particle's mass, to the known expression $r_0 = e_0^2/mc^2$. Thus, r_0 corresponds to the classical electron radius. It is shown that the electron has a regular relativistic energy-momentum four-vector and that its energy-momentum tensor satisfies the Laue theorem.